Volume 24, Number 20 October 31, 1970

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 41504, 41505, 41646, 42067, and 42296.

Chemical and Spectral Procedures

41172 (AERE-R-6310) ELECTRON MICROPROBE ANALYSIS OF METALLIC INCLUSIONS FORMED IN IRRADIATED $PuO_{2.0}$ AND $PuO_{1.7}$ AT HIGH BURNUPS. Davies, J. H.; Ewart, F. T. (Atomic Energy Research Establishment, Harwell (England)). Jun 1970. 14p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

Metallic inclusions formed in irradiated specimens of $PuO_{1.7}$ and $PuO_{2.0}$ at high burnups (~25 at. %) and relatively low temperatures (~450°C) were analysed semiquantitatively, using a CAMECA MS85 electron microprobe. The inclusions formed in $PuO_{1.7}$ contained molybdenum, technetium, ruthenium, rhodium, and palladium; those in $PuO_{2.0}$ contained no molybdenum and little technetium. The chemical significance of this observation is discussed. The high radiation levels associated with the specimens reduced the detection sensitivity of the microprobe. Instrumental modifications were designed to alleviate this problem. (auth) (UK)

41173 (DP-Report-374) THE USE OF GAS CHROMATOGRAPHIC METHODS OF GAS ANALYSIS IN THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Gray, P. S.; Owens, D. R. (Atomic Energy Establishment, Winfrith (England)). Sep 1965. 30p. Dep. CFSTI.

An account is given of the employment of gas chromatographic techniques to some of the analytical problems encountered during commissioning and operation of the OECD Dragon HTGC Reactor and possible future applications are discussed. Some details of the instruments in use are given including a description of a novel instrument for the analysis of almost pure helium. (auth)

41174 (DP-Report-384) THE STUDY OF IRRADIATED AND UNIRRADIATED COATED FUEL PARTICLES BY THE X-RAY MICROPROBE. Project DRAGON. Quataert, D.; Schleicher, H. W. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Oct 1965. 36p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, England.

Methods for the examination of coated fuel particles using the x-ray microprobe are described. The determination of low concentrations of U in graphite and the analysis of highly radioactive, fully irradiated particles necessitated special alterations to equipment and procedures, which resulted in a remarkable improvement in precision. Examples of the results obtained on different types of particles are presented. (auth)

41175 (DP-Report-392) EXPERIMENTS ON PRECONCENTRATION OF IMPURITIES IN HELIUM GAS BY THERMAL DIFFUSION AND THE MEASURING OF THERMAL DIFFUSION FACTORS. Project DRAGON. Velds, C. A.; Grotendorst, H. W.; Los, J.; De Vries, A. E. (Atomic Energy Establishment, Winfrith (England)). Jan 1966. 14p. (CONF-660318-4). Dep. CFSTI.

From Dragon Contractors' Research and Development Symposium, Harwell, Eng.

In order to extend the range of analysis for impurities in helium gas, thermal diffusion experiments to preconcentrate CO_2 were carried out. It is shown that a thermal diffusion column with a length of 100 cm, having a diameter of 20 mm and a heating cylinder at 360°C (diameter 13 mm) could fulfil these requirements. The thermal diffusion factors of trace components Xe, Kr, Ar, CO_2, O_2, N_2, CO, H_2O, CH_4, and H_2 in helium at 20 atm are given and are equal to the thermal diffusion factors at 1 atm pressure. The thermal diffusion factor of He–CO_2 was measured as a function of temperature, pressure, and concentration. (auth)

41176 (EURFNR-756) DETERMINATION OF FREE ACID IN PLUTONIUM(IV) SOLUTIONS. Thiele, D.; Baehr, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Translation of report KFK-1133. 15p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 29178.

41177 (IS-2059) BIBLIOGRAPHY OF MASS SPECTROSCOPY LITERATURE FOR THE FIRST HALF OF 1968, COMPILED BY A COMPUTER METHOD. Capellen, J.; Svec, H. J.; Jordan, J. R.; Sun, R. (comps.) (Ames Lab., Iowa). Aug 1970. Contract W-7405-eng-82. 463p. Dep. CFSTI.

This report covers the first half of 1968 and lists 4589 articles of interest to mass spectroscopists. The report consists of three sections; a Bibliography section, an Author Index section, and a Key Word Out of Context Index (KWOC Index) section. The Bibliography section lists the authors, the title, and the source for each article. The Author Index lists the authors' names and the reference numbers of their articles. The KWOC Index lists the key words, the reference numbers of the articles in which the key word appears, and the first 100 characters of the title. (auth)

41178 (JEN-214-DQ/I-76) ESTABLISHMENT OF EXPERIMENTAL VARIABLES FOR THE DETERMINATION OF RARE EARTHS BY X-RAY FLUORESCENCE SPECTROMETRY. APPLICATION TO CONCENTRATIONS OF OXALATES AND SULFATES. Bayon Fuentes, A.; Bermudez Polonio, J. (Junta de Energia Nuclear, Madrid (Spain). Division de Quimica). 1969. 9p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

A previous theoretical and experimental study was carried out in order to analyze the rare earths elements by x-ray fluorescence spectrometry. All possible spectral interferences were considered. The working conditions for each element were selected, taking into account the peak/background ratio values for the following parameters: tungsten, molybdenum, and chromium targets, current and voltage, analyzing crystals, and scintillation and flow proportional counters. Calibration curves were plotted showing the concentration of rare earth elements in oxalates and potassium sulfate matrices, and the theoretical detection limits for each element were calculated. (auth)

41179 (KFK-1149) ACTIVITY OF OXYGEN IN LIQUID SODIUM. de la Torre, M. (Kernforschungszentrum, Karlsruhe (West Germany)). Feb 1970. 19p. (In German). Dep. CFSTI (U. S. Sales Only).

It is shown how the distribution coefficient for a specific sodium system can be determined and how a quantitative calibration could be achieved by oxygen addition. Moreover, the dependency on temperature of the electrochemical oxygen meter is reported. The equilibrium between the oxygen content on the metal surfaces of the system and in the sodium and its dependency on temperature seem to play a major part in this case. This results in a new relation concerning the dependency on temperature of the oxygen

meter. This relation might be able to explain the bad agreement with the experimental data so far determined. (auth)

41180 (NP-10466) A NEW METHOD TO MEASURE THE CONCENTRATION OF CHARCOAL DUST IN AN AIR STREAM. Project DRAGON. Enzmann, H. F. (Atomic Energy Establishment, Winfrith (England)). Jun 1961. 8p. (DP-Report-35). Dep. CFSTI.

In the Dragon reactor experiment, extensive use is made of charcoal beds for removing impurities from the helium coolant. During the process the gas stream becomes contaminated with charcoal dust. A program of experimental work was done in connection with this dust problem. A method of measuring the concentration of charcoal dust in an air stream, based on the inflammability of the dust is described. (auth)

41181 (NP-18305) EVALUATION OF ACCURACY AND PRECISION OF ISOTOPIC ANALYSES OF URANIUM. Bokelund, H. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Dec 1969. 19p. (ETR-250). Dep. CFSTI (U. S. Sales Only).

The reliability of isotopic analyses of uranium and plutonium by thermal ionization mass spectrometry is evaluated in terms of accuracy and precision. Experimental results on the uranium standard series from National Bureau of Standards, USA are presented. On this basis the bias of the Eurochemic measurements can be found. The average bias of the U-235/U-238 ratio is about 0.06% over discrete ratios between 0.005 and 17. None of the bias is statistically significant. The coefficient of variation of a ratio determination as found from replicate measurements of these standards over 3 years is presented as a linear function of the ratio in a log-log graph. This error estimate accounts for internal as well as external errors. A minimum error (expressed as relative standard deviation of a single analysis) of 0.3% for a ratio of unity is found by regression analysis on the precision data (83 degrees of freedom). The coefficient of variation of ^{235}U abundances of unknown samples is estimated from duplicate analyses over several months. This estimate agrees well with the coefficient of variation as calculated from the above mentioned regression line established from measurements of the NBS standards. (auth)

41182 DETERMINATION OF SELENIUM AND STRONTIUM IN GLASS AND RAW MATERIALS BY X-RAY FLORESCENCE. USE OF DIFFUSE IRRADIATION. Heyndryckx, P.; Chenebaux, J. Vetro Silicati; 12: No. 72, 5-13(1968). (In French).

The method proposed uses one or more diffuse baselines as internal standards and has the advantage that effects of matrix and particle size are overcome. Curves were established for each of the 3 standards with 3 different glasses and one glass composition with 12 different ranges of SeO_2 added varying from 10 to 10,000 ppM. The curves obtained were substantially straight lines but with a slight angle at ~200 ppM, especially when plotted on log-log scale. When tested on 5 different glasses the variation of results from one glass to another was ≤10%. The Sr content of 3 colemanites was checked by means of the calibration curve established. The process is useful only for heavy elements in light matrices; it is not entirely free from interference, for Se, for example, the presence of As in the glass composition interfered with 1 standard line and the presence of ZrO_2 in one of the glasses tested also interfered with 1 standard line. Tablets of glass without preliminary preparation provide good test values further improving the speed of the process. Compared with atomic absorption analysis, the results obtained for Sr were within the limits of experimental error even with solid specimens. (Selenium-Tellurium Abstr.)

41183 CONTRIBUTIONS TO THE ANALYTICAL CHEMISTRY OF OSMIUM AND RUTHENIUM. IX. THE DIMERCAPTO DERIVATIVES OF ASYMMETRIC TRIAZINE AS COLOR REAGENTS FOR OSMIUM. Popa, Gr.; Lazar, C.; Cristescu, C. (Univ. of Bucharest, Chemical Pharmaceutical Research Inst., Bucharest). Talanta; 17: 635-8(Jul 1970).

The parameters of the reaction of osmium with 3,5-dimercapto-6-(ethylcarboxy)-1,2,4-triazine were studied and the optimum conditions for the spectrophotometric determination of osmium over the range 0.5 to 18.0 ppM determined. The coloured product contains the components in the ratio 1:2 metal:ligand. (auth) (UK)

41184 USE OF THE POLAROGRAPHIC METHOD FOR QUANTITATIVE DETERMINATION OF LOW CONTENTS OF SOME ELEMENTS IN SILICATE ROCKS. Sochevanov, V. G. Acta Geol. Geogr. Univ. Comenianae, Geol.; 15: 127-45(1968). (In Russian).

Methods of separation, concentration, and determination are given for Re, Nb, Zn, Cd, Bi, Mo, Pb, Cu, Te, As, Hg, and Os. (Selenium-Tellurium Abstr.)

41185 DETERMINATION OF DYSPROSIUM IN BORATE GLASSES. Reisfeld, Renate; Greenberg, E.; Kraus, S. (Hebrew Univ., Jerusalem); Contract NBS (G) 83. Anal. Chim. Acta; 51: 133-7(Jul 1970).

Optimal conditions for the analytical determination of Dy in glasses were found from a detailed study of the excitation and emission spectra. The best procedure, in the absence of other interfering rare earths, such as Tb, Sm, and Eu, which emit in the vicinity of 578 nm, is the fluorometric determination at this wavelength. The 485-nm fluorescence can be used if elements interfering with the 578-nm line are present. When Tb is present it can be determined also by excitation at 232 nm and the Dy concentration measured by difference. (P.C.H.)

41186 THE DETERMINATION OF THORIUM WITH HEXAMMINE COBALT(III) CHLORIDE. Ueno, K.; Hoshi, M. (Japan Atomic Energy Research Inst., Tokai). Radiochem. Radioanal. Lett.; 4: 221-9(31 Jul 1970).

Hexaamminecobalt (III) chloride is proposed as a new reagent for the gravimetric and radiometric determination of thorium. As the gravimetric method has a favorable analytical factor (0.2505) it is well suited to the standardization of thorium solutions. The method is also rapid and simple, but there is some interference by some foreign ions. (auth)

41187 OBSERVATION OF THE ν_4 BAND URANIUM HEXAFLUORIDE AND THE DETERMINATION OF THIS GAS BY FAR INFRA-RED SPECTROSCOPY. Chantry, G. W. (National Physical Lab., Teddington, Eng.): Gebbie, H. A.; Hamlin, A. G.; Lomas, B. C. Infrared Phys.; 10: 95-6(Jun 1970).

Reference is made in particular to the determination of UF_6 in diffusion process gas streams, and typically the determination of about 100 parts UF_6 in million parts of nitrogen carrier gas, with significant amounts of other fluorides, such as HF possibly present. An instrument was constructed to monitor UF_6 concentration using the absorption near 625 cm^{-1} due to the ν_3 fundamental. Serious interference from impurities is, however, encountered in this frequency range. At the frequency of 183 cm^{-1} no interference is expected, and if the absorption at this frequency were found to be intense then measurements of attenuation could provide a convenient method for monitoring the UF_6 concentration. With this in mind a study was made of the far infra-red spectra of UF_6 vapour. An NPL/Grubb Parsons modular interferometer, followed by digital Fourier transformation in an Elliott 903B computer was used to obtain the spectra, and the sample had a considerable quantity of HF present as impurity. A typical spectrum is shown. It was found that the ν_4 band is well suited in intensity as a basis of a method for the quantitative analysis of UF_6. Experimental arrangements are indicated. (UK)

41188 MODERN ANALYTICAL TECHNIQUES FOR METALS AND ALLOYS. PART 1. Bunshah, R. F. (ed.). Techniques of Metals Research. Volume III, Part 1. New York; John Wiley and Sons, Inc. (1970). 451p. $22.00.

All aspects of the chemical characterization of a material are considered. Topics covered include: brief survey of various analytical techniques used for metals and alloys, separation and preconcentration techniques, vacuum fusion and extraction and inert gas fusion techniques, combustion methods for carbon and sulfur, electroanalytical techniques, analytical flame spectroscopy, spectrophotometry and spectrofluorometry, x-ray spectroscopic methods, and soft x-ray spectroscopy in metals research. (M.C.G.)

41189 ORE SORTING SYSTEM BASED ON X-RAY FLUORESCENCE. Goodman, R. H.; Josling, C. A.; Bettens, A. H. (Dept. of Energy, Mines, and Resources, Ottawa). Met. Soc. Conf.; 49: 1-12(1968).

From Symposium on Continuous Processing and Process Control, Philadelphia, Pa. See CONF-661219.

An ore-sorting system using x-ray fluorescence was developed in the Mines Branch laboratories. This system allows the upgrading of an ore in the early stages of processing, thus achieving significant savings in the processing costs. Elements in the ore are detected using x-ray fluorescence techniques. The characteristic x-rays are excited using β particles (electrons) from an artificially produced radioactive ^{90}Sr source. These β particles bombard the material and produce characteristic x rays, which are used to indicate the presence of valuable mineralization in the sample. The radiation resulting from this electron bombardment of the ore is detected in a proportional counter system, the output of which is analysed with respect to energy. When radiation of an energy corresponding to the characteristic x rays of a desirable element is detected, the material being scanned is transferred to the "good bin." If no mineralization has been detected after three examinations, the material is rejected as waste. (auth)

41190 COMPUTER EVALUATION OF NaI(Tl) AND Ge(Li) GAMMA-RAY SPECTRA. Quittner, P. (Central Research Inst. for Physics, Budapest); Wainerdi, R. E. At. Energy Rev.; 8: 361-415(Jun 1970).

The vast amount of information collected by modern semiconductor and scintillation detectors has led to a widespread use of computers in interpreting and evaluating gamma spectra. In this review a description is given of how computer programs can be used to smooth statistical fluctuations in measured spectral data, to construct detector response functions, and to find the significant peaks. Methods for calculating intensities by weighted least-squares analysis and by peak area are explained. The accuracy and the precision of the calculated results and the most probable experimental errors that can lead to erroneous results, if not properly corrected, are described. Illustrative examples of applied gamma spectroscopy, as decay-curve analysis, optimization, and activation analysis programs are given. (112 references). (auth)

41191 NEW EXTRACTION AGENT FOR CESIUM: COMPLEX OF CATECHOL WITH ARSENIC ACID. Rais, J.; Selucky, P.; Drazanova, S. (Nuclear Research Inst., Rez, Czech.). Radiochem. Radioanal. Lett.; 4: 195-202(31 Jul 1970).

The extraction of Cs into nitrobenzene from acidic media in the presence of arsenic acid–catechol complex was studied. Separation factors from some other elements are given, as well as the distribution of arsenic between water and nitrobenzene. (auth)

41192 PHOTOMETRIC DETERMINATION OF URANIUM WITH ERIOCHROME CYANINE R AND PYROGALLOL RED AS CHROMOGENIC REAGENTS. Prakash, O.; Verma, J. R.; Mushran, S. P. (Allahabad Univ., India). Chim. Anal. (Paris); 52: 655-8(Jun 1970). (In French).

Eriochrome Cyanine R and Pyrogallol Red form violet chelates with U(VI) at pH 4 to 6. The composition of the chelates was confirmed and the constant of stability calculated by the continuous variation method and the mole ratio method. The effects of various ions were also studied. (auth) (France)

41193 POLAROGRAPHIC DETERMINATION OF SELENIUM AND TELLURIUM. Lysenko, V. I.; Lisitsyna, E. V. Sb. Nauch. Tr. Vses. Nauch.-Issled. Gorno-Met. Inst. Tsvet. Metal.; No. 13, 42-6(1968). (In Russian).

Clear Se and Te reduction waves were observed in a supporting electrolyte of 2N H_2SO_4 at −0.65 and −0.95 V vs SCE by using an oscillographic polarograph and at −0.9 and −1.18 V vs a Hg anode by using an ac polarograph. Wave heights had a constant value at concentrations of 2 to 4N H_2SO_4; the Te wave height was 2.5 times more than Se. Displacement of $E_{\frac{1}{4}}$ and change in the half-peak width with the concentration change of H_2SO_4 indicated formation of variable stability complexes. Simultaneous determination of Se and Te was possible at concentration ratios of 1:1 to 1:1.5 and a maximum content of Se(Te) 0.5 mg/l. Sensitivity in Se determination was 0.05 mg/l, Te 0.02 mg/l (oscillopolarographically) and 0.02 to 0.01 mg/l for Se and Te (ac polarography). As^{5+} (<5 mg/l) did not interfere in the determination of Se and Te; presence of ≤0.5 mg Cu/l improved the Se and Te polarograms, Se and Te wave heights decreased sharply in the presence of Cd. (Referativnyi Zh.)

41194 SPECTROPHOTOMETRIC STUDY OF THE REACTION OF URANIUM(VI) WITH A NEW SALICYLAZOCHROMOTROPIC ACID DERIVATIVE. Baiulescu, Gh.; Marinescu, D.; Greff, C. (Univ. of Bucharest). Analyst; 95: 661-4(Jul 1970).

As part of a study of substituted salicylic acid groups as functional analytical groups in the determination of uranium(VI), a new bissalicylazochromotropic derivative was synthesized, i.e., the 3,6-bis(4-carboxy-3-hydroxyphenylazo)-4,5-dihydroxynaphthalene-2,7-disulphonic acid, as the tetrasodium salt. This reagent gives a sensitive reaction with uranium(VI), which enables between 0.5 and 16 $\mu g\ ml^{-1}$ of uranium to be determined. Uranium(VI) combines with the reagent in the ratio 1:2, and the instability constant of the compound formed is 1.2×10^{-9}. (auth) (UK)

41195 OBSERVATIONS ON THE EFFECT OF ORGANIC SOLVENTS IN THE DIRECT-READING EMISSION-SPECTROMETRIC DETERMINATION OF TRACE ELEMENTS IN RARE EARTH COMPOUNDS BY ROTATING ELECTRODE. Osumi, Y.; Kato, A.; Miyake, Y. (Government Industrial Research Inst., Oaska). Z. Anal. Chem.; 251: 7-11(1970).

A direct-reading emission-spectrometric method was applied in the presence of methanol for the quantitative determination of traces of rare earths and diverse other elements in rare-earth compounds by the rotating electrode. Addition of alcohols with lower boiling points than water causes an increase of the rate of vaporization of the sample solution and of the emission intensity. Methanol enhances the emission intensity to a larger extent than other alcohols and permits the determination of microquantities of the elements within limits of detection from 1 to 37 ppM in high-purity rare-earth compounds. The intensity ratio of the ionic line to the atomic line increases in the presence of more than 60% methanol, indicating the elevation of plasma temperature. (auth)

41196 DIRECT POTENTIOMETRIC DETERMINATIONS WITH ION-SENSITIVE ELECTRODES USING COMPLEXING AUXILIARY REACTIONS. Oehme, Friedrich; Dolezalova, Ludmila (Polymetron AG, Zurich). Z. Anal. Chem.; 251: 1-6(1970). (In German).

The basic principles of the direct-potentiometric determination of several cations and anions, for which no ion-sensitive electrode is available are discussed. The decrease in concentration of an auxiliary ion, which forms stable complexes with the ion to be determined, is measured. Detailed information is given on the determination of Al^{3+} with F^- as auxiliary ion and of Ni^{2+} with CN^- as auxiliary ion. An outlook is presented on the possible determinations of Fe^{2+}, Fe^{3+}, Au^+, Hg^{2+}, Th^{4+}, Zr^{4+}, UO_2^{2+}, SCN^-, and $S_2O_3^{2-}$. (auth)

41197 PHOTOMETRIC DETERMINATION OF CERIUM IN ALLOY STEELS. Blazejak-Ditges, Dagmar (Thyssen-Roehrenwerke AG, Duesseldorf). Z. Anal. Chem.; 251: 11-15(1970). (In German).

Photometry with o-tolidine was found to be a sensitive, exact, and simple procedure to determine <0.1% cerium in steel. The precipitation with oxalate is recommended as a simple method to separate cerium from the other elements occurring in steels. With high-alloy steels a double precipitation is necessary. This involves a loss of 4% of cerium which, however, is reproducible and thus can be considered in calibrating. Ce content from 0.002 to 1.0% can be determined. (auth)

41198 LOKAL'NYI SPEKTRAL'NYI ANALIZ MINERALOV. (Spectral Analysis of Indigenous Minerals). Marzuvanov, V. L. Alma-Ata, USSR; Izdatel'stvo Nauka Kazakhskoi SSR (1969). 52p.

A method is described for local spectral analysis of minerals in polished cross sections. Data were obtained for identification of various minerals and methods for quantitative determination of each element. An atlas of spectral lines covering the wave length from 2310 to 4970 Å, the range of the most sensitive lines for 63 elements (including La, W, Mo, Nb, Th, U, and Zr), is included. (28 references) (R.V.J.)

41199 ATOMIC ABSORPTION SPECTROMETRIC DETERMINATION OF STRONTIUM, CALCIUM, AND MAGNESIUM IN SEAWEEDS. Fujita, Tetsuo; Shigematsu, Tsunenobu. (Kyoto Univ.). Jap. Anal.; 19: 893-9(Jul 1970). (In Japanese).

A method for the determination of strontium, calcium and magnesium in seaweeds by atomic absorption spectrochemical analysis was examined. For the simultaneous determination of these elements in one solution of a sample, the standard addition method was suitable for strontium and the calibration-line method was recommended for calcium and magnesium. Addition of 500 ppM of strontium and 250 ppM of calcium was effective for the elimination of influence of coexisting elements and acid for the determination of calcium and magnesium. The condition recommended for strontium, calcium, and magnesium were, respectively, wavelength 4607 Å, 4227 Å, and 2852 Å, hollow cathode lamp current 13 mA, 6 mA, and 7 mA, slit with 100 μ, 100 μ, and 100 μ, hydrogen pressure 0.5 kg/cm^2, 0.5 kg/cm^2, and 0.4 kg/cm^2 and air pressure 1.0 kg/cm^2, 1.2 kg/cm^2, and 1.0 kg/cm^2. (auth)

41200 SPECTROPHOTOMETRIC DETERMINATION OF THORIUM WITH CARBOXYARSENAZO. Motojima, Kenji; Yamamoto, Tadashi; Muto, Hiroshi; Kato, Yoshiharu (Japan Atomic Energy Research Inst., Tokai). Jap. Anal.; 19: 935-8(Jul 1970). (In Japanese).

A spectrophotometric method is described for determination of thorium. In 0.3 M nitric acid, thorium forms a colored complex with carboxyarsenazo {2-(2-carboxyphenylazo)-7-(2-arsonophenylazo)chromotropic acid}. The complex has absorption maxima at 630 and 675 mμ. The molar absorptivity at 675 mμ is ca 3.5×10^4, and Beer's law holds over the range of 0 ~ 6.0 μg Th/ml. Zirconium interferes, but less than 1 mg of uranium or rare earth elements does not interfere with the determination of 100 μg of thorium. (auth)

41201 SPECTROPHOTOMETRIC MICRO-DETERMINATION OF BERYLLIUM AND THORIUM BY SOLOCHROME AZURINE B. S. Sharma, C. L.; Tandon, S. N. (Univ. of Roorkee, India). Z. Anal. Chem.; 250: 383(1970).

Solochrome azurine B. S. was used for the quantitative determination of beryllium and thorium. The dye reacts with these

elements in acetate buffer to form a deep violet 1 : 1-complex. The following ions caused serious interferences: Ca^{2+}, VO_2^+, UO_2^{2+}, Al^{3+}, Zr^{4+}, Ce^{4+}, S^{2-}, SO_3^{2-}, $C_2O_4^{2-}$, PO_4^{3-}, and AsO_4^{3-}. No interference was found in the presence of Na^+, K^+, Rb^+, Cs^+, Tl^+, Ba^{2+}, Mg^{2+}, Sr^{2+}, Cd^{2+}, Pb^{2+}, Sn^{2+}, Cu^{2+}, Mn^{2+}, Zn^{2+}, Hg^{2+}, Ni^{2+}, Cr^{3+}, Sb^{3+}, La^{3+}, Ce^{3+}, Cl^-, Br^-, I^-, CN^-, NO_2^-, NO_3^-, CH_3COO^-, $B_4O_7^{2-}$, and SO_4^{2-}. (J.G.B.)

41202 STUDY OF SUGAWARA'S METHOD FOR THE DETERMINATION OF IODINE IN SEA WATER. Matthews, A. D.; Riley, J. P. (Liverpool Univ.). Anal. Chim. Acta; 51: 295-301(Aug 1970).

Several sources of error have been found in Sugawara's method for the determination of iodine in seawater. These are minimized in the modified procedure which has been developed. Iodide is coprecipitated quantitatively with silver chloride by silver ions slowly liberated into the water by the dissolution of silver citrate. The iodide present in the precipitate is oxidized to iodate by means of bromine under the influence of ultrasonic agitation. After destruction of hypobromite, iodine is determined either by photometric titration or by spectrophotometry. Iodate is not coprecipitated by silver chloride, but can be determined after reduction with hydrazine sulfate. The titrimetric and spectrophotometric methods give recoveries of iodide- and iodate-iodine of 99.0 ± 0.4% and 98.5 ± 0.6% respectively, and have coefficients of variation of ±0.4% and ±0.8%. (auth)

41203 ADVANCES IN INVERSE VOLTAMMETRY. PART I. TECHNIQUE AND DETERMINABLE ELEMENTS. Monien, H. (Institut fuer Spektrochemie und Angewandte Spektroskopie, Dortmund, Ger.). Chem.-Ing.-Tech.; 42: 857-66(Jul 1970). (In German).

Inverse voltammetry can be used for the determination of many cations and anions at concentrations as low as 10^{-8} to 10^{-9} M. Experimental techniques of the method are reviewed. In addition, a number of general informative viewpoints outlining the scope of application, as well as a review of all the elements which can be determined are given. A number of important determinations are given in order to illustrate practical applications of the method. (auth)

41204 VOLUMETRIC DETERMINATION OF IODIDE ION WITH Hg-EDTA USING MERCURY(II)-THYMOLPHTHALEINCOMPLEXONE AS AN INDICATOR. Nomura, Toshiaki; Komatsu, Sumio (Shinshu Univ., Matsumoto, Japan). Nippon Kagaku Zasshi; 90: 590-3(Jun 1969). (In Japanese).

The colorless reagent, thymolphthaleincomplexone (TPC), reacts with mercury (II) to form mercury (II)-thymolphthaleincomplexone (Hg-TPC), a light blue complex which reacts with the equivalent amount of iodide ion to form the blue mixed ligand complex Hg-TPC-I. When the mixed ligand complex Hg-TPC-I reacts with iodide ion to form mercury (II) iodide and TPC, the blue solution becomes colorless. On the other hand, colorless mercury (II) ethylenediaminetetraacetate(Hg-EDTA), reacts with iodide ion to form a colorless mixed ligand complex. However, this complex does not react with iodide ion to form mercury (II) iodide and EDTA. Thus, the following procedure was developed for the volumetric determination of iodide ion. Five ml of TPC, mercury (II) nitrate, and iodide solutions of 1×10^{-4} mole/l were added to the iodide sample solution which had been adjusted to pH 8.4 to 9.6. It was diluted to about 40 ml with water. This solution was titrated with the standard Hg-EDTA solution of 1×10^{-2} mole/l until the color of this solution changed to blue from colorless. Iodide ion content was calculated by using the titer which was determined with the solution of known iodide ion content. (auth)

41205 STUDIES ON REAGENTS FOR NIOBIUM AND TANTALUM. VI. SPECTROPHOTOMETRIC DETERMINATION OF Nb(V) AND Ta(V) WITH DIBROMOGALLIC ACID. Ackermann, Gerhard; Koch, Siegfried (Bergakademie, Freiberg, Ger.). Talanta; 17: 757-9(Aug 1970). (In German).

Procedures are given for the spectrophotometric determination of Nb(V) and Ta(V) with dibromogallic acid, in the presence of various masking reagents. The sensitivities and standard deviations for the procedures are given, and the interfering elements in each case are listed. (auth) (UK)

41206 HIGH-SOLID SAMPLES IN ATOMIC-ABSORPTION FLAME SPECTROPHOTOMETRY. Hell, August; Ramirez-Munoz, Juan (Beckman Instruments, Inc., Fullerton, Calif.). Anal. Chim. Acta; 51: 141-9(Aug 1970).

The determination of low analyte concentrations in samples with high concentrations of concomitants is discussed. Highly saline samples often cause problems when examined with burners designed for high-sensitivity operation, unless they are very greatly diluted. Use of new burners designed to handle solutions with high-solid contents is described and illustrated with some practical examples. These burners which operate with cold spray chambers, offer improvements of sensitivity compared with other cold-operation burners, as well as low clogging disturbances and low memory effects. They also can be used with strongly acidic solutions and with a wide variety of flames. (auth)

Isotopic Procedures

Refer also to abstract 41723.

Radiometric Procedures

Refer also to abstracts 41420, 41707, 41875, and 42285.

41207 (DP-Report-360) DEVELOPMENT OF PHYSICAL METHODS OF FUEL ANALYSIS. Semi-Annual Technical Report, October 1964-February 1965. Project DRAGON. Paul, H.; Viehboeck, F. P. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf, Physik-Institut). Jul 1965. Contract CON/WIN/52317/2. 23p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, England.

A library of standard gamma spectra for the collimator geometry was established, which should make possible the analysis of samples in the mCi range by gamma spectrometry and computer programs. Spectra of graphite samples from various irradiation experiments were taken. The radial distribution of fission products in one graphite sample was qualitatively determined by scanning the sample. The spectrum of the sample was also measured on a high-resolution Compton spectrometer. By resistance heating of coated fuel particles, samples for the mass spectrometer were prepared. An improved device for this method of sample preparation, suitable for glove box operation, was designed. Mass spectrometer samples were also prepared by the arc erosion method, directly from fuel compacts. (auth)

41208 (DP-Report-366) DETERMINATION OF THE ENRICHED URANIUM CONTENT OF SAMPLES BY GAMMA SPECTROMETRY. Project DRAGON. Pointud, R. G. (Atomic Energy Establishment, Winfrith (England)). Nov 1965. 36p. Dep. CFSTI.

A procedure is described that employs the gamma spectrometer for determining the ^{235}U content of green and sintered fuel kernels, coated particles, and consolidated fuel cartridges. It is also shown that the method may be used to assess the homogeneity of fuel distribution in fuel cartridges. Results of measurements are given and the accuracy and limitations of the method are indicated. It is concluded that the technique is easy, rapid and non-destructive. (auth)

41209 (DP-Report-376) DEVELOPMENT OF PHYSICAL METHODS OF FUEL ANALYSIS. Semi-annual Technical Report, March 1965-July 1965. Project DRAGON. Paul H.; Viehboeck, F. P. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf, Physik-Institut). Sep 1965. Contract CON/WIN/52317/2. 15p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, England.

Using the methods described in previous progress reports, gamma scintillation spectra of fuel samples from Pluto 8 and of graphite samples from Pluto 8, HPD 14 and 16, and LTHPD 1 irradiation experiments were taken which are to be analyzed by computer methods. To complete the library of standard spectra used for that purpose, a few additional standards were measured. A number of triple filament inserts for mass-spectrometric analysis of compact fuel were prepared by the arc erosion method and were analyzed at AWRE, Aldermaston. Difficulties arose due to the small ion currents obtained and due to fracture of filaments However, when the uranium was deposited first on a carbon electrode and subsequently removed by electrolysis, satisfactory results could be obtained. Uranium mass ratios for Pluto 8 fuel were measured. (auth)

41210 (NEDO-13074) A THEORETICAL PHOTON TRANSPORT REPRESENTATION OF STRONGLY COLLIMATED GAMMA SCAN EXPERIMENTS (GE-APED PROGRAM HOTROD, 15 NOVEMBER 1969). Egan, M. R. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jun 1970. 53p. (70-NED-5).

Using the first-collision monoenergetic photon transport kernel, a theory was written that simulates conditions typical of collimated gamma-scan experiments. The theory is based on free-flight photon penetration of a finite sized detector with no successive collision correction. Although the theory treats general source distributions of a suitably localized nature, special attention is given to the rod-in-bundle configuration found in BWR design. Expressions are derived for single-rod Green's functions and for the counting angular distribution of each rod in the source config-

uration. Program logic specialized to the rod-in-bundle source configuration is described (GE-APED Computer Program HØTRØD), along with input and output relevant to calculation of source rod Green's functions and angular distributions. (auth)

41211 DETECTION OF FREE IONS IN LABELED OILS. Michailov, M.; Sorantin, H. (Reaktorzentrum, Seibersdorf, Austria). J. Chromatogr.; 50: 103-11(8 Jul 1970). (In German).

For the detection of free radionuclide ions in labeled mineral and vegetable oils and some of their components thin-layer chromatography, paper chromatography, and paper electrophoresis were used. According to the results obtained, thin-layer chromatography was particularly suitable for the examination of ^{51}Cr-, ^{59}Fe- and ^{65}Zn-labeled oils, whereas for ^{82}Br-labeled compounds paper electrophoresis was the method of choice. (auth)

41212 DETERMINATION OF SULPHATE ION BY REPLACEMENT OF IODATE IN ^{131}I LABELLED BARIUM IODATE. Bowen, H. J. M. (Reading Univ., Eng.). Analyst; 95: 665-7(Jul 1970).

Between 2 and 100 μmoles of sulphate (60 to 3200 μg of sulphur) can be determined in aqueous solution by passing the solution through a column of ^{131}I-labelled barium iodate and counting the filtrate. The blank can be reduced by using 20% methanol. Each determination takes only a few minutes, and the precision is ±2.5%. The apparatus required is simple and inexpensive, apart from the counting equipment. The method was tested with standard kale, and was applied to the determination of sulphur in fruticose lichens. (auth) (UK)

41213 RAPID AND SENSITIVE ASSAY FOR DNA SYNTHESIS IN LEUCOCYTE CULTURES. Rubbins, J. H.; Burk, P. G.; Levis, W. R. (National Institutes of Health, Bethseda, Md.). Lancet; 2: 98(11 Jul 1970).

An adaptation of a filter trap/scintillation counting technique is described, as used to determine the incorporation of radioactive thymidine into the DNA of lymphocytes. This was used as a means of evaluating scheduled DNA synthesis in leucocyte cultures. In this technique, a 'Millipore' filter trapped a sample's radioactive cells, and after being washed and dried, was accurately placed with respect to the most sensitive portions of the scintillation spectrometer's phototubes, in order to give a reproducible counting geometry for each filter. Phytohemagglutinin (P.H.A.) stimulated 0.5 ml cultures yielded 1.5 to 3.0×10^5 c.p.m. by the 3rd day's culture while unstimulated control cultures usually yielded less than 0.2% of this activity. Decreases in the percentage of cells containing radioactive DNA resulted in proportionate decreases in cpm. At least 99.7% of radioactivity on the filters of P.H.A. stimulated cultures was removed after treatment of the filters with DNA-ase. Counting efficiency was increased at least 2 fold by combusting filters and contents to tritiated water. (UK)

41214 ANALYSIS OF AIR POLLUTANTS. Leithe, W. Ann Arbor, Mich.; Ann Arbor–Humphrey Science Publishers (1970). 311p. $18.75.

Translation of Die Analyse der Luft und Ihrer Verunreinigungen in der Freien Atmosphaere und am Arbeitsplatz by R. Kondor.

Information is given on general sanitation, technology, and legislation, methodology, laboratory investigations with prepared air mixtures, special analytical methods, special topics, and analysis of organic air pollutants. The origin and extent of air pollution, combined with meteorological factors, are weighed against the damage it does to man and plants. From these facts the necessary legal limits (MIK- and MAK-values) are derived. Also, a survey of basic technical possibilities for preventing air pollution is presented. The chapter on air analysis gives a comprehensive survey on how to plan the experiments and sampling procedures. Distinction is made between long-term procedures and individual determinations. The chapter on special topics first discusses pollutants in the form of dust and smoke, and includes a brief introduction on radioactive pollutants. Sections on more important pollutants discuss their analytical chemistry, origin, propagation, hygiene, and the present state of techniques for waste gas elimination. The analytical part facilitates the selection of appropriate methods it gives the concentration to be expected, the presence of other pollutants, and the instrumental means available. (P.C.H.)

41215 INDIRECT TRITIUM ASSAY OF ORGANIC COMPOUNDS. Fenton, D. F.; Mackay, J. P.; Creedon, P. B. (University Coll., Cork, Ireland). Chem. Ind. (London); No. 29, 956 (18 Jul 1970).

Since many ^3H-labeled macromolecules are insoluble in standard scintillation solvents, a combustion step to water and CO_2 is often necessary; this may be achieved conveniently using the Schoniger Flask combustion technique (Analyst 86:3(1961)), but its application to tritium assay has necessitated a number of modifications. The efficiency of this procedure using an ethane–toluene system was examined, and measured specific activities were found to be lower than predicted, indicating incomplete recovery of the tritiated water. A comparative study was made of various solvents as take-up agents for the tritiated water of combustion. It was found that ethanol, methanol, and isopropanol are effective as take-up agents. A decrease in efficiency with sample weight, however, which was observed in some cases, may have been due to inability of the solvent to absorb as efficiently an increased volume of water of combustion. A methanol–toluene system was more efficient than the ethanol–toluene system used earlier. (UK)

41216 RADIOACTIVE KRYPTONATES IN VOLUMETRIC ANALYSIS. X. RADIOMETRIC TITRATIONS BASED ON REDOX REACTIONS. Toelgyessy, J.; Dillinger, P.; Pruzinec, J.; Varga, S. (Slovak Technical Univ., Bratislava). Radiochem. Radioanal. Lett.; 4: 231-6(31 Jul 1970).

A method was worked out for determination of iodine by redox titration with 10^{-3}N $Na_2S_2O_3$ as titrant and radioactive kryptonate AgSCN [^{85}Kr] as end-point indicator. Titration was carried out by the discontinuous method, by measuring the activity of radioactive kryptonate. (auth)

41217 COMPARISON OF THREE METHODS FOR DETERMINATION OF GROSS BETA ACTIVITY IN NATURAL WATERS. Picer, M. (Inst. for Medical Research, Zagreb). Arh. Hig. Rada Toksikol.; 19: 217-24(1968). (In Serbo-Croatian).

Two evaporation methods and an ion exchange method for determination of gross beta activity in natural waters are compared. The analytical procedure for the three methods is described and the time of analysis as well as the handling of analyzed samples are discussed. Results of analysis of gross beta activity obtained by these methods in naturally contaminated rain, cistern, and river waters are given. Simplicity, accuracy, and reproducibility of each method are discussed and the method of concentrating radionuclides on a thin ion exchange resin bed is commended as optimum. (auth)

41218 COMPOSITION DIFFERENCES AT SURFACES DETECTED BY ADSORPTION AND DESORPTION OF RADIOTRACERS. Brandreth, Dale A.; Johnson, Rulon E. (E. I. du Pont de Nemours and Co., Wilmington, Del.). Science; 169: 864(28 Aug 1970).

A method for the detection of composition differences on solid surfaces is based on differences in the adsorption and subsequent partial desorption of a radiotracer by heterogeneities of the surface. (auth)

41219 RADIOCHEMICAL ASSAY OF LONG-CHAIN FATTY ACIDS USING ^{63}Ni AS TRACER. Ho, R. J. (Vanderbilt Univ., Nashville). Anal. Biochem.; 36: 105-13(Jul 1970).

The ^{60}Co radiochemical assay of long-chain free fatty acids (FFA) was adapted to use ^{63}Ni as a tracer. In a proper partition mixture, ^{63}Ni was obtained in the organic (upper) phase in stoichiometric relation to FFA present. From this phase it was easily sampled and counted. The simplicity, reliability, sensitivity, and specificity of both ^{60}Co and ^{63}Ni radiochemical assay were comparable. Like the ^{60}Co assay, the ^{63}Ni method is not suitable for medium- or short-chain FFA without proper standards. A linear standard curve was obtained from 1 to 40 nmoles of long-chain FFA/assay. The FFA/Ni molar ratio in a Ni–FA complex is about 2 as determined by double-isotope experiments. This factor of 2 can be used to calculate the quantity of FFA tested without a FFA calibration curve. Phospholipid interferes with the recovery of ^{63}Ni as well as ^{60}Co in the organic phase. A simple procedure for measuring FFA in 10 μl of serum is described. (auth)

41220 DEGRADATION OF ACETATE-^{14}C: MODIFICATION OF ROSEMAN'S BENZIMIDAZOLE PROCEDURE. Gordis, Enoch (Rockefeller Univ., New York). Anal. Biochem.; 36: 168-73 (Jul 1970).

Roseman's benzimidazole procedure for the degradation of radioactive acetate was reviewed and modified. A solvent system for scintillation counting of the radioactive products formed is described. (auth)

41221 COMPARATIVE STUDIES OF LIQUID SCINTILLATION COUNTING OF AQUEOUS ^{14}C SAMPLES. Mostafa, I. Y.; Fallin, Elizebeth; Fang, S. C. (Oregon State Univ., Corvallis). Anal. Biochem.; 36: 238-43(Jul 1970).

Three frequently used water-miscible solvent systems (Bray, Prockop, and toluene–Triton X-100) for counting ^{14}C-labeled carbonate, glucose, and benzene were compared separately and in combination. The results indicated that within a given solvent system, the counting efficiency varies between samples; and within

a given sample, the counting efficiency is dependent upon the amount of water or other solubilizing agents. The effects of NaOH or organic bases were also studied. (J.G.B.)

41222 DETERMINATION OF HYDROGEN IN GASES BY PROTON RECOIL. Ashirov, P. M.; Kozlov, A. E.; Starchik, L. P. (Tadzhik State Univ., Stalinabad, USSR). Zavod. Lab.; 36: 561-2(1970). (In Russian).

It is proposed that the content of hydrogen in gases be determined by recoil protons emerging from the interaction of rapid neutrons with hydrogen nuclei. The recoil nuclei of the heavier elements in the gases do not hit in the scintillation detector used for recording the recoil protons because it is protected by aluminum foil. The sensitivity of the measurement at a measurement time of 10 min is 0.1%. (tr-auth)

41223 RADIOACTIVE KRYPTONATES AND THEIR USES IN CHEMICAL ANALYSIS. Toelgyessy, J.; Varga, S. (Technical Univ., Bratislava). Talanta; 17: 659-81(Aug 1970).

Radioactive kryptonates are defined and classified and their preparation and properties described. A review of their uses in chemical analysers is given under the following headings: analysis of gases (oxygen, hydrogen, ozone, sulphur dioxide, fluorine); analysers; analysis of solutions (water in organic solvents, hydrochloric acid, iron in aqueous solutions, dichromate, vanadate, oxygen dissolved in water and other fluids); radioactive kryptonates in titrimetric analysis (discontinuous titration, continuous titrations); radiocomplexometric titration (determination of calcium, strontium, magnesium, iron, nickel); precipitation titration (use of radioactive kryptonates of metals and of glass, use of redox indicators) neutralization titration (use of radioactive kryptonates of metals and of glass). (63 references) (UK)

41224 CHROMATOGRAPHIC AND ELECTROPHORETIC TECHNIQUES. VOLUME I. CHROMATOGRAPHY. THIRD EDITION. Smith, Ivor (ed.). New York; John Wiley and Sons, Inc. (1969). 1094p.

The use of chromatography in biochemical investigations is discussed. Abstracts were prepared for two of the forty chapters. (D.H.M.)

For abstracts of individual chapters see: 41225 and 41226.

41225 CHROMATOGRAPHY OF RADIOACTIVE SUBSTANCES. Moses, V. pp 643-65 of Chromatographic and Electrophoretic Techniques. Vol. I. /Smith, Ivor (ed.). New York; John Wiley and Sons, Inc. (1969).

Methods for the detection and assay of radioactive materials on paper chromatograms are presented. Topics discussed include handling of radioactive materials, automatic chromatogram scanning, radioautography, location by end-window Geiger–Muller tubes, tritium counting, liquid scintillation counting of excised chromatogram spots, and thin-layer chromatography of radioactive substances. (D.H.M.)

41226 SPARK CHAMBER TECHNIQUE FOR RADIOCHROMATOGRAMS. Hesselbo, T. pp 693-713 of Chromatographic and Electrophoretic Techniques. Vol. I. /Smith, Ivor (ed.). New York; John Wiley and Sons, Inc. (1969).

The cross-wire spark chamber and coil spark chamber techniques for radiochromatograms are described. The spark chamber technique speeds up the evaluation of a two-dimensional chromatogram by a factor of 1000 for ^{14}C and ^{35}S, and even more for tritium in comparison to autoradiography. (D.H.M.)

Activation Procedures

Refer also to abstracts 41430, 41655, 41725, and 41728.

41227 (COO-1705-5) PARTICLE SIZE DISTRIBUTION OF CHLORINE AND BROMINE IN MID-CONTINENT AEROSOLS FROM THE GREAT LAKES BASIN. Loucks, Ronald H.; Winchester, John W. (Michigan Univ., Ann Arbor. Dept. of Meteorology and Oceanography). Aug 1969. Contract AT(11-1)-1705. 181p. Dep. CFSTI.

A study of the role of aerosol Br and Cl in the atmosphere is presented in which Br and Cl were determined by neutron activation analysis. (D.H.M.)

41228 DETERMINATION OF DISSOLVED URANIUM CONTENTS IN HOT SPRING WATERS OF KOREA. Lee, Chul; Cho, Won Ji; Park, Keung Shik (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul); 9: No. 2, Pt. 1, 17-19(Apr 1970). (In Korean).

Dissolved uranium contents in hot spring waters were determined by thermal-neutron activation analysis. It was found that You-Sung hot spring water contains abnormally high amounts of uranium compared to other hot spring waters. Places where samples were collected and determined and the uranium contents ($\mu g/l$) found are as follows: You-Sung (41.1 ± 2.1), Soo-An-Bo (7.24 ± 0.31), On-Yang (5.20 ± 0.53), Duk-San (2.82 ± 0.30), Do-Go (0.99 ± 0.10), Dong-Rae (3.35 ± 0.27), Hae-Oon-Dae (0.544 ± 0.067), Baek-Am (0.165 ± 0.017). (auth)

41229 SUBSTOICHIOMETRIC DETERMINATION OF CHROMIUM IN ALUMINIUM ALLOYS. Baishya, N. K.; Heslop, R. B. (Univ. of Manchester, Eng.). Anal. Chim. Acta; 51: 69-76 (Jul 1970).

Chromium in aluminum-base alloys has been determined by activation analysis and by isotope dilution using the substoichiometric principle. Chromium, separated by oxidation to dichromate followed by solvent extraction, was substoichiometrically extracted with tetraphenylarsonium chloride into 1,2-dichloroethane and assayed by measurement of its γ emission. (auth)

41230 DETERMINATION OF CAESIUM IN BIOLOGICAL MATERIAL BY NEUTRON ACTIVATION ANALYSIS. Heinonen, J.; Haesaenen, E. (Technical Univ. of Helsinki, Otaniemi, Finland). Radiochem. Radioanal. Lett.; 4: 181-7(31 Jul 1970).

A method was developed for Cs determinations in biological specimens by neutron activation analysis using the short-lived radioisotope ^{134m}Cs. Following irradiation, the sample, ashed at 400°C, is dissolved in 6M HNO_3 into which stable Cs is added as a carrier with a known amount of ^{137}Cs for yield determination. For the chemical separation of Cs, two inorganic ion exchange columns are used. An antimony pentoxide column is used first to remove ^{24}Na quantitatively, after which the solution is run through an ammonium molybdophosphate (AMP) column, which adsorbs the Cs quantitatively. A counting source is prepared from the AMP-column and its γ-activity is determined using a 3" × 3" NaI (Tl) crystal and a multichannel analyzer. The Cs contained in the sample is determined on the basis of the area of the 129-keV peak of ^{134m}Cs. Yield correction is made using the 662-keV peak of ^{137}Cs in the γ spectrum. (auth)

41231 DETERMINATION OF SULFUR AND CHLORINE IN PHOSPHORS BY FAST NEUTRON ACTIVATION ANALYSIS. Persiani, C.; Cosgrove, J. F. (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). Radiochem. Radioanal. Lett.; 4: 203-13(31 Jul 1970).

A method for the rapid and nondestructive determination of sulfur and chlorine in phosphors by 14-MeV neutron activation is described. Precision of the method, interferences found, and comparison to other methods are discussed. (auth)

41232 OXYGEN DETERMINATION IN SEMICONDUCTOR MATERIAL USING 14-MeV NEUTRON ACTIVATION. Adamek, A.; Severa, F. (Inst. of Physics, Bratislava). Radiochem. Radioanal. Lett.; 4: 215-20(31 Jul 1970).

An oxygen analyzer–OXAN–(neutron generator NG-1/total neutron yield of the order of 10^{10} $nsec^{-1}$/, pneumatic transfer system, sequence programmer, and counting device) developed for the fast neutron activation analysis of the oxygen content in various materials was used for analysis of semiconductor Ge, GaAs, and InSb. The sensitivity obtained was of the order of 100 ppM O_2 at ±30% of accuracy. The absolute amount of oxygen determined was: 144 ± 38 ppM in Ge, 177 ± 53 ppM in GaAs and in InSb below the sensitivity of determination. (auth)

41233 ANALYTICAL METHOD FOR OXYGEN IN METALLIC BERYLLIUM. Chiba, M. (National Research Inst. for Metals, Tokyo). Bunseki Kiki; 8: No. 1, 27-35(Jan 1970). (In Japanese).

For the determination of oxygen in metallic beryllium, such methods as (1) chemical method, (2) gas analysis, (3) nuclear chemical or radioactivation analysis, and (4) mass spectrometry, are widely used. The procedure used in method (1) is comparatively simple, but it is suitable only for analysis of samples with relatively high oxygen content, and it lacks accuracy. Method (2) is not useful for beryllium, because Be has strong affinity with oxygen, its melting point is comparatively high, and the vapor pressure of metallic Be is high. Method (3) is very efficient in that oxygen of several ppM or below can be quickly determined nondestructively. In this case, the bremsstrahlung or 14-MeV neutrons are used as radiation source; the first variation utilizes (γ, n) reaction, while the latter uses (n,p) reaction. In the analytical method based upon the other special nuclear reactions, charged particles, such as p, d, ^3H, ^3He and α, are used. For example, in the case of radioactivation analysis by ^3He, the detection limit of oxygen can be down to several ppB (10-7%). By method (4), oxygen can be determined down to 0.03 atomic ppM (ca. 5×10^{-4} wt. %) with a double focused mass spectrometer, in due consideration of sample electrode and photographic emulsion. (auth) (Japan)

41234 DETERMINATION OF COPPER AND GOLD TRACE IMPURITIES IN HIGH PURITY GALLIUM BY ACTIVATION ANALYSIS WITH PRETREATMENT. Nagy, L. G. (Technical Univ., Budapest); Toeroek, G.; Giber, J.; Szokolyi, L. Period. Polytech. Chem. Eng.; 14: 149-56(1969).

A distillation method has been worked out to remove the gallium matrix, utilizing the significant vapor tension differences between the gallium trichloride and the chlorides of the investigated impurities. The main point of the method is the reaction between the metallic gallium sample and dry chlorine gas. In this way 99% of the gallium matrix can be removed, and thus the total activity of the initially 100 mg gallium is reduced to below 20 mCi. After the distillation process a well-defined portion of the investigated impurities is retained, and the distillation efficiency is governed by technological factors. According to the data it was possible to determine the copper content at a concentration range of 10^{-6} to 10^{-7} g/g with ±40% deviation, and the gold content at a concentration range of 10^{-8} to 10^{-9} g/g with ±50% deviation. (auth)

41235 DETERMINATION OF COPPER IN IRON AND STEEL BY 14-MeV NEUTRON ACTIVATION ANALYSIS. Van Grieken, R.; Speecke, A.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta; 51: 151-62(Aug 1970).

A fast (10 min) nondestructive determination of copper in steel and cast iron by 14-MeV neutron activation is described. The 0.511-MeV annihilation radiation of ^{62}Cu ($T_{\frac{1}{2}}$ = 9.8 min), induced by the reaction $^{63}Cu(n,2n)^{62}Cu$, is counted by two opposing NaI(Tl) detectors operating in coincidence. An oxygen flux monitor is used to normalize the irradiations. For high phosphorus contents, two measurements are made and the 9-min activity contribution is calculated. As the iron content of the samples is known, the use of pure iron samples allows correction for ^{53}Fe activity from the reaction $^{54}Fe(n,2n)^{53}Fe$ ($T_{\frac{1}{2}}$ = 8.9 min). When the phosphorus and silicon activities are low, the procedure of counting and computing can be greatly simplified. Nuclear interferences of most common alloying and impurity elements were investigated. The precision is 2 to 3% for steels containing above 1% Cu, and ca 10% for 0.1% Cu. (auth)

41236 RADIOCHEMICAL NEUTRON ACTIVATION ANALYSIS OF INDIUM, CADMIUM, YTTRIUM, AND THE 14 RARE EARTH ELEMENTS IN ROCKS. Rey, P.; Wakita, H.; Schmitt, R. A. (Oregon State Univ., Corvallis). Anal. Chim. Acta; 51: 163-78(Aug 1970).

Indium, cadmium, yttrium, and the 14 rare earth elements were simultaneously separated in the U. S. Geological Survey standard rocks, BCR-1 (basalt), G-2 (granite), and DTS-1 (dunite), and determined by γ-spectrometry with a 3 × 3 in NaI(Tl) well crystal and associated electronics. This method enabled the accurate determination of all the rare earths within a short time compared with instrumental methods. Indium and cadmium were separated in about 1.5 and 4 hr, respectively. Results for indium, cadmium, and the rare earths were in excellent agreement with literature values. Indium and cadmium showed decreasing concentrations in the sequence BCR-1/G-2/DTS-1. Relative to the rare earth distribution pattern in chondritic meteorites, the rare earth patterns observed in BCR-1 and G-2 were similar to other basalts and granites; however, the rare earth pattern in DTS-1 was V-shaped with a minimum at terbium and was similar to rare earth patterns observed in olivine minerals. (auth)

41237 DETERMINATION OF INDIUM IN SEA WATER. Matthews, A. D.; Riley, J. P. (Liverpool Univ.). Anal. Chim. Acta; 51: 287-94(Aug 1970).

A chelating ion-exchange technique is used for the concentration of indium from seawater. After purification by chloro-anion exchange, the separated indium is determined by neutron activation. The concentration of indium in Atlantic Ocean water was found to be ca 0.1 ng l^{-1}. The method has a sensitivity of 0.006 ng l^{-1}. (auth)

41238 ACTIVATION ANALYTICAL DETERMINATION OF ELEMENTS IN METEORITES. 3. DETERMINATION OF MANGANESE, SODIUM, GALLIUM, GERMANIUM, COPPER, AND GOLD IN 21 IRON METEORITES AND 2 MESOSIDERITES. Bauer, R.; Schaudy, R. (Reactor Center, Seibersdorf, Austri Univ. of Vienna). Chem. Geol.; 6: 119-31(Jul 1970).

A method is described that allows the determination of germanium (down to ≈0.05 μg) in iron meteorites or other alloys using neutron activation analysis. Distillation is employed to separate radioactive germanium from the considerable residual activity and further purification can be effected by means of an extraction step. Also Na, Mn, Cu, Ga, and Au are determined by activation analysis as described by Schaudy et al. (1967). In comparison to the results of others, a satisfactory agreement of the trace element values found has been obtained. The Ga–Ge groups according to Lovering et al. (1957), could be verified only partially, if their limits are extended considerably. (auth)

41239 FACTORS INVOLVED IN ON-STREAM TRACE ACTIVATION ANALYSIS. Al-Shahristani, H.; Jervis, R. E. (Univ. of Toronto). Nucl. Appl. Technol.; 8: 456-64(May 1970).

A theoretical treatment of on-stream activation analysis is given based on the nuclear and flow phenomena involved. A dilute solution of natural uranium in water is considered for illustrative purposes and to demonstrate the application of the mathematical models developed to a practical analytical problem. However, the underlying principles and the mathematical treatment are quite general and are equally applicable to on-stream activation analysis of similar systems. Experimental measurements in uranium and thorium solutions will eventually be reported. It was found that an arrangement in which continuous plug flow of a fluid stream is irradiated and counted simultaneously will lead to the highest count-rate at a given concentration of the element under analysis. Cases of interrupted and well-stirred flow conditions were also studied and compared. Continuous and pulsed irradiation and counting arrangements were also compared and the advantages and shortcomings of each system are discussed. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 41187, 41194, 41338, 41406, 41408, 41495, 41507, 42109, 42178, 42207, 42210, 42226, 42227, 42239, 42247–42249, 42256, 42264, and 42272.

41240 (BNWL-1421) REACTIONS OF THE SESQUIOXIDES OF Pm, Nd, AND Sm WITH WATER. Fullam, H. T.; Roberts, F. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 34p. Dep. CFSTI.

The reactions of Pm_2O_3, Nd_2O_3, and Sm_2O_3 with water were investigated. Thermograms were obtained for the reaction products, as well as for the hydroxides of promethium, neodymium, and samarium prepared by precipitation techniques. The solubility and dissolution rates of Pm_2O_3 in distilled water and synthetic seawater were determined. (auth)

41241 (CEA-Bib-180) HIGH-TEMPERATURE SOLID ELECTROLYTES. Marcon, Jean-Pierre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr 1970. 40p. (In French). Dep. CFSTI (U. S. Sales Only).

The use of solid electrolytes, such as CaF_2, ThO_2, ZrO_2, and CeO_2, at high temperatures for obtaining thermodynamic properties of compounds is reviewed. After some theoretical considerations, the general case of the ionic conductivity in oxides is discussed. Finally, some practical uses of these electrolytes in thermodynamics are given. (41 references). (auth)

41242 (CEA-N-1246) PROGRESS REPORT ON THE MAIN STUDIES UP TO JANUARY 1, 1969. Billard, Francois (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1 Jan 1970. 38p. (In French). Dep. CFSTI (U. S. Sales Only).

Developments are reported for studies on: method for retention and observation of aerosols in the electron microscope; collection of charged aerosols; generation and labeling of latex polystyrene spheres; atmospheric pollution by ultrafine particles; efficiency of charcoal at high temperatures relative to iodine and methyl iodide; radiation effects on formation processes for methyl iodide; permeability of materials for tritium and water-t_2; efficiency of polluted charcoal for removal of iodine from coatings or solvents; acceptance of activated charcoal to be used in the manufacture of traps for iodine; and method for measuring the efficiency of filters for uranin. (P.C.H.)

41243 (DP-Report-363) STUDIES ON THE DELAY AND TRAPPING OF FISSION PRODUCT NOBLE GASES. Project DRAGON. Shorrock, J. C.; Staub, H.; Burckhardt, Ch. (Battelle Memorial Inst., Geneva (Switzerland)). Jul 1965. 59p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

Studies are reported on the delay and trapping of fission product noble gases. The methane-helium-activated charcoal adsorption system equilibrium was studied from 77 to 135°K. Investigations were made of the adsorption of a binary mixture of krypton and methane in helium and the results obtained, together with various attempts to analyze them "thermodynamically" and thereby permit the prediction of mixed adsorption equilibria. (auth)

41244 (LIB/Trans-283) ON THE QUESTION OF THE EXISTENCE OF (U $Dipy_3$)$(SCN)_6$. Herzog, S.; Waicenbauer, W. Translated by P. J. F. Newton (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Z. Chem.; 6: 383(Oct 1966). 3p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 21: 15884. (Australia)

41245 (NACAR-10005) REVIEW OF KRYPTON-XENON ADSORBER DESIGN. PART I. Kovach, J. Louis (North American Carbon, Inc., Columbus, Ohio. Research and Development Dept.). 1 Jun 1970. 79p.

The sorptive properties of various activated carbons for Kr and Xe are discussed. The currently available theory, data, and design technology for the sizing of krypton-xenon adsorbers, both under ambient and cryogenic conditions, are reviewed. (M.C.G.)

41246 (NP-10470) THE ADSORPTION OF HELIUM ON COCONUT CHARCOAL AT-196°C AND AT PRESSURES BETWEEN 1 AND 23 ATMOSPHERES. Project DRAGON. Horsley, G. W. (Atomic Energy Establishment, Winfrith (England)). Jul 1961. 9p. (DP-Report-48). Dep. CFSTI.

The quantity of helium adsorbing on type 208C charcoal at 20 atmospheres and -196°C was found to be 37.5 ml. (N.T.P.)/g. Analysis of the isotherm suggests that the saturation value of the charcoal is ~150 ml. (N.T.P.)/g. and there is thus no evidence that the charcoal in the low temperature charcoal beds in the Dragon coolant clean up circuit will be saturated with helium. (auth)

41247 (ORNL-tr-2342) BEHAVIOR OF TRIVALENT ACTINIDES AND LANTHANIDE ELEMENTS IN CHLORIDE SOLUTION. Marin, Bernard (Paris Univ. (France). Faculte des Sciences). Translated for Oak Ridge National Lab., Tenn., from report CEA-R-3803. 108p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 28: 40612.

41248 (ORNL-tr-2350) ON THE FLUORINATION OF PROTACTINIUM. Laser, M.; Merz, E. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from J. Inorg. Nucl. Chem.; 31: 349-60(1969). 14p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 11497.

41249 (TID-25480) STUDIES OF THE SUPEROXIDE ION AND OTHER SOLUTE SPECIES IN MOLTEN FLUORIDES. Whiting, Fred L. (Oak Ridge National Lab., Tenn.). Aug 1970. 79p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The existence of O_2^- ion in molten LiF-NaF-KF at 500°C was established. The absorption spectrum of O_2^- in molten LiF-NaF-KF at 500°C consists of a band at 254 nm. The band position for the O_2^- ion was found to be at 252 nm in liquid ammonia. Raman spectral results show the vibrational frequency of the O_2^- ion in molten LiF-NaF-KF to be at 1107 ± 3 cm^{-1}. A novel voltammetric-spectrophotometric technique was employed in an attempt to obtain the spectra of some high oxidation state species in molten LiF-NaF-KF. The species were generated at a microelectrode positioned in the optical aperture of a captive liquid cell. The utility of the method was demonstrated by obtaining a spectrum of U(III) generated by the reduction of U(IV) in molten LiF-BeF_2-ZrF_4 at 540°C. The spectrum of the U(IV)-U(III) mixture is given. The electrochemical studies of the oxidation of Ta(V) in molten LiF-NaF-KF were in essential agreement with the previous work. Spectral evidence could not be obtained for Ta(VI). No evidence, electrochemical or spectral, was obtained for the existence of Cu(III) in molten LiF-NaF-KF at 500°C. Potassium hexafluorocuprate(III) decomposed when added to the melt. The spectrum of Cu(II) in molten LiF-NaF-KF at 500°C consists of a broad band at 880 nm. Cobalt(III) fluoride decomposed when added to molten LiF-NaF-KF at 500°C; whereas, a solution of CoF_3 in molten KHF_2 at 250°C was obtained, but spectral results were inconclusive due to the turbidity of the melt. The absorption spectrum of Mn(II) in molten LiF-NaF-KF at 500°C consists of a weak band at 408 nm. The CrO_4^{2-} ion produced in molten LiF-NaF-KF at 500°C exhibited bands at 372 and 265 nm. Raman spectral evidence is also reported for CrO_4^{2-} in molten LiF-NaF-KF. A method for the removal of chromium ions, as well as some other metallic ions, from molten fluoride melts is discussed. The treatment was effective in removing at least 95% of the chromium which was present originally at a concentration of 7 ppM. (auth)

41250 CO-ORDINATION COMPLEXES OF NIOBIUM AND TANTALUM. X. POLYMERIC OXO-OXALATO TANTALATES(V). Brnicevic, N.; Djordjevic, C. (Inst. Rudjer Boskovic, Zagreb. Univ. of Zagreb). J. Less-Common Metals; 21: 469-71(1970).

Hydrated compounds with the formula $M(I)_2[Ta_4O_8(C_2O_4)_3]2H_2O$ where M(I) = Na, K, Rb, Cs, ½Ba, were prepared. These polymeric tantalates can be separated from a variety of tantalum(V) oxalato solutions. The salts have similar properties: they are practically insoluble in all the common solvents and can be decomposed only in hot mineral acids. Their x-ray powder diffraction patterns are diffuse, indicating the presence of very finely divided material. The ir spectra of these polymeric salts proved to be of some diagnostic value with regard to the characteristic bands of oxalato groups and of metal-oxygen bonding. The spectra of all the salts are almost identical. The TGA diagrams of all the salts were also very similar. Evidence indicated that the structure involves Ta-O-Ta bridges and three coordinated oxalates per four tantalum ions, and may possibly involve some terminal Ta-O bonds. (P.C.H.)

41251 NMR STUDY OF THE FERROELECTRIC TRANSITIONS IN DIGLYCINE NITRATE AND TRISSARCOSINE CALCIUM CHLORIDE. Blinc, R. (Univ., Ljubljana, Yugoslavia. Inst. Josef Stefan, Ljubljana, Yugoslavia); Jamsek-Vilfan, M.; Lahjnar, G.; Hajdukovic, G. J. Chem. Phys.; 52: 6407-11 (15 Jun 1970).

A proton magnetic resonance spin-lattice relaxation and second moment study of the ferroelectric transitions in diglycine nitrate (DGN), trissarcosine calcium chloride (TSCC), and its deuterated analog was performed. The results support the order-disorder model of the ferroelectric transition in these compounds and demonstrate the freezing in of a "flipping" mode on going to the ferroelectric phase in analogy with triglycine sulphate. Deuteration results in a shift of the Curie temperature of TSCC from 127 to 149°K. (auth)

41252 COMPLEXES WITH SIX-MEMBERED CHELATE RINGS. II. PROTON MAGNETIC RESONANCE STUDY OF TRIMETHYLENEDIAMINE, SOME METHYL-SUBSTITUTED DERIVATIVES, AND THEIR COMPLEXES WITH PLATINUM(II) AND PALLADIUM(II). Appleton, T. G.; Hall, J. R. (Univ. of Queensland, Brisbane). Inorg. Chem.; 9: 1807-14(Aug 1970).

PMR spectra of compounds (diamine)$(HCl)_2$, M(diamine)$_2^{2+}$, and M(diamine)$(NH_3)_2^{2+}$ are reported, where M = Pt(II), Pd(II); diamine = trimethylenediamine, 2-methylpropane-1,3-diamine, pentane-2,4-diamine, neopentanediamine, ethylenediamine, or mesa-butane-2,3-diamine. These spectra are discussed in terms of the conformational behavior of the chelate rings. An unusual Pt-H coupling over four saturated bonds was observed in some complexes. (auth)

41253 COMPLEXES WITH SIX-MEMBERED CHELATE RINGS. I. PREPARATION OF PLATINUM(II) AND PALLADIUM (II) COMPLEXES OF TRIMETHYLENEDIAMINE AND SOME METHYL-SUBSTITUTED DERIVATIVES. Appleton, T. G.; Hall, J. R. (Univ. of Queensland, Brisbane). Inorg. Chem.; 9: 1800-6 (Aug 1970).

Complexes containing six-membered rings and, for comparison, five-membered rings, M(diamine)Cl_2, M(diamine)$_2^{2+}$, M(diamine)$(NH_3)_2^{2+}$, were prepared, where M = Pt(II), Pd(II); diamine = trimenthylenediamine, 2-methylpropane-1,3-diamine, pentane-2,4-diamine, neopentanediamine, meso-butane-2,3-diamine, and ethylenediamine. The geometric isomers of pentane-2, 4-diamine were reassigned. Some aspects of the infrared spectra of the complexes are discussed. A correlation can be made between structure and color in tetrachloroplatinate salts. (auth)

41254 INFRARED SPECTRA OF LIQUID H_2O AND D_2O. Bonner, O. D.; Curry, Janice D. (Univ. of South Carolina, Columbia). Infrared Phys.; 10: 91-4(Jun 1970).

Infrared spectra are reported for liquid H_2O and D_2O using a differential technique. This technique gives sharper bands whose positions were determined with greater certainty than those reported earlier in the literature. Frequency shifts upon liquefaction gave evidence for greater association in H_2O than in D_2O. (auth) (UK)

41255 PHOTOLYSIS OF CYCLOPENTANONE. Blades, A. T. (Research Council of Alberta, Edmonton). Can. J. Chem.; 48: 2269-73(15 Jul 1970).

The effect of wavelength and pressure on the distribution of products was studied in the photolysis of cyclopentanone and cyclopentanone-2,2,5,5-d_4. At low pressure, C_2D_4 and C_2H_4 are formed in addition to the expected high pressure product $C_2H_2D_2$, confirming the intermediate formation of excited cyclobutane. The high pressure ratio of cyclobutane to ethylene is attributed to alternate reactions of the tetramethylene diradical which have equal energy sensitivity, and some evidence is presented for a further mechanism of ethylene formation at short wavelengths.

Evidence is also presented for the formation of cyclobutane and ethylene following thermal re-excitation of the precursor of 4-pentenal. (auth) (Canada)

41256 VAPOR PRESSURE AND PERIODICAL CLASSIFICATION OF CHEMICAL ELEMENTS. Codegone, Cesare (Politecnico, Turin). Termotecnica (Milan); 24: 122-6(Mar 1970). (In Italian). (CONF-691047-1).

24th Conference of Italian Association for Heat Techniques, Bari, Italy.

The periodic classification of chemical elements is shown to be related to their thermodynamic properties. It is shown that on (log p), (1/T) diagrams the lines of vapor pressure p of the elements, for each group or subgroup of the Mendeleev's classification, have a convergence point. For each group or subgroup a unique equation may be developed in which the single element is represented by the coordinates of a point only. This rule, even with some exceptions, and approximations, may be able to supply missing information, to explain discordant experimental results, and to produce values of thermodynamic parameters such as heats of evaporation and specific heats. Numerical examples are presented for rare earth elements and rare gases of the atmosphere. (auth)

41257 VAPORIZATION OF PLUTONIUM CARBIDES. Marcon, J. P. (CEN, Fontenay-aux-Roses, France). J. Inorg. Nucl. Chem.; 32: 2581-90(Aug 1970). (In French).

The vapor pressures of different plutonium carbides were measured by the Knudsen effusion method, and the domains PuC + Pu_2C_3, Pu_2C_3 + C, PuC_2 + C and Pu_2C_3 + PuC_2 were particularly studied. The relation between the Pu–C diagram and the vaporization curves on the one hand and the very large influence of oxygen in vaporization phenomena on the other hand were evidenced. The following energies of formation were obtained: $\Delta H_{298}(PuC_{0.9})$ = –10.5 Kcal and $\Delta H_{298}(PuC_{1.5})$ = – 15.9 Kcal. These were compared with the results obtained by other thermodynamic measurements (calorimetry, f.e.m. methods, determination of equilibrium pressures in Pu–C–O system). (auth) (UK)

41258 NEW COMPLEXES OF TRIPHENYLPHOSPHINE OXIDE WITH METAL PERCHLORATES. Karayannis, N. M.; Mikulski, C. M.; Strocko, M. J.; Pytlewski, L. L.; Labes, M. M. (Drexel Inst. of Tech., Philadelphia). J. Inorg. Nucl. Chem.; 32: 2629-40(Aug 1970).

New metal perchlorate complexes of triphenylphosphine oxide (TPPO) were synthesized and characterized by means of spectral, magnetic, conductance, and x-ray powder diffraction studies. Of particular interest is a pentacoordinated Cr(III) complex, which involves a trinuclear cation. Each Cr(III) ion is in a low symmetry trigonal bipyramidal ligand field, consisting of terminal and bridging TPPO molecules and one coordinated monodentate perchlorato group. The possibility of a polynuclear complex cation is also discussed for the Mg(II) complex on the basis of far ir evidence. This complex was formulated as $[Mg(TPPO)_4]_n(ClO_4)_{2n}$(n = 1,2, . . .). The rest of the complexes reported were formulated as follows: $[M(TPPO)_4(OClO_3)_2](ClO_4)$ (M = Cr, Ce, In); $[Fe(TPPO)_4](ClO_4)_2$; $[UO_2(TPPO)_4](ClO_4)_2$; $[Ca(TPPO)_4(O_2ClO_2)](ClO_4)$; $[Th(TPPO)_4(O_2ClO_2)](ClO_4)_3$. In the case of the Th(IV) complex, its formulation as $[Th(TPPO)_4(O_2ClO_2)_2](ClO_4)_2$ can not be ruled out. (auth) (UK)

41259 FAST IONIC REACTIONS IN SOLUTION. VIII. THE FISSION AND FORMATION KINETICS OF THE DIMERIC ISOPOLYBASE $(UO_2OH)_2^{2+}$. Frei, Vaclav; Wendt, Hartmut (Univ., Erlangen-Nuernberg, Ger.). Ber. Bunsenges. Phys. Chem.; 74: 593-9(Jun 1970).

The fission of the dimeric species $(UO_2OH)_2^{2+}$ was investigated μ = 0.5 M and 3°C with the stopped-flow-method. On mixing prehydrolyzed $UO_2(NO_3)_2$ solutions with $HClO_4$ solutions in a fast protolytic step the conjugate acid $(UO_2OHUO_2)^{3+}$ is formed. The dissociation constant of this acid is $(1.3 \pm 0.2) \cdot 10^{-3}$ M. In the rate determining step the protonated dimer $(UO_2OHUO_2)^{3+}$ dissociates with a rate of (65 ± 10) sec^{-1}. The fission reaction of the protonated species is enhanced further at higher concentrations of hydrogen ions. Therefrom it can be concluded that the species $(UO_2OH)_2^{3+}$ can be protonated twice. The doubly protonated species is relatively stable and its first acid dissociation constant can be estimated from the experiments to be $2.5 \cdot 10^{-2}$ M. Thus the dimeric species $(UO_2OH)_2^{+}$ behaves quite dissimilar to the other dimeric isopolybases hitherto investigated (dimers of Fe^{3+} and VO_2^{+}) as its conjugate acid and diacid are remarkably stable. The rate of fission of the diacid proceeds with k ≈ 1000 sec^{-1}. From the kinetics of the fission reaction the following conclusions for the formation reaction of the dimer $(UO_2OH)_2^{2+}$ can be drawn: the rate determining step for the fusion of one uranyl mono hydroxo cation and one uranyl ion to form the dimer, $UO_2^{2+} + UO_2OH^{+} \rightarrow (UO_2OHUO_2)^{3+}$, is the rate of spontaneous water exchange on the cation UO_2^{2+}; dimerization reaction of two uranyl ions to form $(UO_2H_2OUO_2)^{1+}$ is remarkably slower than the rate of water exchange on UO_2^{2+}. Since the reaction investigated was fast (relative to the dead time of the flow apparatus used) the investigation was restricted to 3°C and no activation parameters were obtained. From T-jump measurements of acidified $UO_2(NO_3)_2$ + KSCN-solutions an estimation of the rate of water exchange on UO_2^{2+} ions is given ($k_{H_2O\text{-}exch}^{UO_2^{2+}} \approx 10^5$ sec^{-1}, 3°C). (auth)

41260 HYDROLYSIS OF THE FOURTH AND FIFTH GROUP TRANSITION METALS. Avgustinik, A. I.; Drozdetskaya, G. V.; Ordan'yan, S. S. Zh. Prikl. Khim.; 43: 1193-6(Jun 1970). (In Russian).

Thermodynamic studies were made on the stability of ZrN in water, and the stability of TiN and ZrN in water were compared. Experimental thermodynamic data on HfN, VN, NbN, and TaN hydrolysis confirmed considerable instability of transition metal nitrides in water systems. (R.V.J.)

41261 PREPARATION AND PROPERTIES OF SOME RARE EARTH AND AMERICIUM CHELATES. Danford, M. D.; Burns, J. H.; Higgins, C. E.; Stokely, J. R. Jr.; Baldwin, W. H. (Oak Ridge National Lab., Tenn.). Inor. Chem.; 9: 1953-5(Aug 1970).

Properties of lanthanide chelates are compared with those of americium chelates of various structure types. 1,1,1,5,5,5-hexafluoro-2,4-pentanedione(Hhfa) was used with cesium to prepare rare earth and Am chelates, $(CsM(hfa)_4$. 2,2,6,6-tetramethyl-3,5-heptanedione(Hthd) was used with and without dimethylforamide (DMF) to prepare rare earth and Am chelates, M(thd)$_3$ and M(thd)$_3$ · 2DMF. Crystallographic data are tabulated. (J.G.B.)

41262 CHELATION OF URANYL IONS BY ADENINE NUCLEOTIDES. III. FURTHER NUCLEAR MAGNETIC RESONANCE INVESTIGATION OF THE URANYL NITRATE–ADENOSINE 5'-MONOPHOSPHATE SYSTEM AT BASIC pH (7.5 TO 11.4). Feldman, Isaac; Rich, Kenneth E. (Univ. of Rochester, N. Y.). J. Amer. Chem. Soc.; 92: 4559-64(29 Jul 1970). (UR-49-1123).

NMR spectra, both proton (^{1}H, 100 MHz) and phosphorus (^{31}P, 40 MHz), were obtained for mixtures of uranyl nitrate and adenosine 5'-monophosphate (AMP) at various stoichiometries and alkalinities. The spectra indicate that in an equimolar mixture (0.1 and 0.05 M) the strong chelate with 1 : 1 stoichiometry (whose structure was previously given as a 2 : 2 sandwich-type dimer), which is exclusively present above pD 10.9, disproportionates below this pD to uncomplexed AMP, sandwich-type chelates (two forms) with 2 : 1 (U : AMP) stoichiometry, and nonsandwich-type complex(es). Only the latter type of complex is present at pD 7.5 in 0.05 M equimolar mixture. The extent of disproportionation and the ligand exchange rate both increase with decrease in pH, probably owing mainly to the competition between uranyl ions and protons for the ribose hydroxyl-oxygen sites. Structures for the 2 : 1 chelates and also 3 : 1 chelates, compatible with the spectra, are given. A series of equilibria is suggested to describe the U–AMP system from pH 2 to 11.5. (auth)

41263 ACID- AND NUCLEOPHILE-CATALYZED ^{18}O EXCHANGE OF PHENYL BENZENETHIOLSULFINATE. NEW INSIGHT INTO THE CHEMISTRY OF SULFENIC ACIDS AND SULFENYL DERIVATIVES. Kice, John L.; Cleveland, James P. (Oregon State Univ., Corvallis). J. Amer. Chem. Soc.; 92: 4757-8(29 Jul 1970).

Results of acid- and nucleophile-catalyzed ^{18}O exchange in ^{18}O-labeled phenyl benzenethiolsulfinate are generally considerably slower than racemization. Labeled thiolsulfinate was subjected to exchange in 60% dioxane. Results provided some new insights into the behavior of sulfenic acids and reactive sulfenyl derivatives in aqueous solution. (D.H.M.)

41264 REACTIONS OF PHOSPHONIC ACID ESTERS WITH NUCLEOPHILES. III. REACTIVITY OF AMINES TOWARD p-NITROPHENYL METHYLPHOSPHONATE. Brass, Herbert J.; Edwards, John O.; Biallas, Michael J. (Brown Univ., Providence). J. Amer. Chem. Soc.; 92: 4675-81(29 Jul 1970).

The rate constants for the reactions of a series of amines with p-nitrophenyl methylphosphonate monoanion (p-NPMP) in water were determined. The reaction is second order, first order each in amine and p-NPMP. Attack at aromatic carbon was detected only for the reaction of piperidine. Pyridine reactivity follows a Brønsted relation with a slope β = 0.35 and a Hammett relation with a slope ρ = –2.1. With certain exceptions, other amines fall close to the Brønsted line. Apparent correlation by amines in general may be fortuitous since reactions of organophosphorus esters in general and p-NPMP in particular appear to be governed in part by the steric nature of the attacking nucleophile. The reactivities of aziridine, pyrrolidine, and piperidine are discussed. (auth)

41265 HYDROLYSIS OF A BORANE CATION DERIVED FROM ETHYL N,N-DIMETHYLGLYCINATE. Miller, N. E. (Univ. of South Dakota, Vermillion). J. Amer. Chem. Soc.; 92: 4564-71(29 Jul 1970).

The rate of hydrolysis of $(CH_3)_3NBH_2N(CH_3)_2CH_2CO_2C_2H_5^+$ was determined by monitoring hydrogen evolution in an apparatus which requires only micro quantities of substrate. After an induction period, the hydrogen evolution was fit by first-order decay of substrate, with $k = 6.5 \times 10^{-4}$ sec^{-1} at 29.8°. Temperature dependence and kinetic isotope effects were explored, and syntheses of several possible intermediates were attempted. A mechanism consistent with all the experimental data invokes saponification of the ester function to produce a polar intermediate, $(CH_3)_3NBH_2N(CH_3)_2CH_2CO_2$, as a first step. Slow intramolecular loss of trimethylamine governed by k gives a cyclic intermediate, $(CH_3)_2NCH_2CO_2BH_2$, which then undergoes a second-order step and subsequent fast hydrogen-producing steps. The cyclic intermediate was isolated from a hydrolysate in dilute base and was characterized. (auth)

41266 NITROGEN INVERSION OF TERTIARY AMINES IN AQUEOUS ACID. Morgan, W. R.; Leyden, Donald E. (Univ. of Georgia, Athens). J. Amer. Chem. Soc.; 92: 4527-31(29 Jul 1970).

The kinetics of the nitrogen inversion of three tertiary amines were studied in aqueous acid solution utilizing high-resolution nuclear magnetic resonance. Line-shape analysis of the AB NMR pattern of methylene protons on each compound provided a measure of the rate of interchange of the magnetic environments of these protons which results upon the reprotonation of the free base following an odd number of inversions. The inversion rate was found to follow a modification of the first-order protolysis reaction given by Grunwald. Inversion rate constants of 10^8 to 10^9 sec^{-1} are estimated. These are compared to inversion rate constants for nitrogen atoms contained in ring systems. A second-order dependence of inversion upon the concentration of amine was also found. The rate law for this inversion process follows very closely the second-order proton exchange reaction for the amine in question. Application of solvent isotope effects to the protolysis rate parameters predicted the observed results of nitrogen inversion in D_2O solutions. (auth)

41267 CRITICAL TEST OF THE ACREE HYPOTHESIS IN NUCLEOPHILIC DISPLACEMENT REACTIONS. Beronius, Per; Pataki, Laszlo (Univ. of Umea, Sweden). J. Amer. Chem. Soc.; 92: 4518-21(29 Jul 1970).

In applying kinetic data for bimolecular reactions involving neutral molecules and ionizable species to the Acree equation, $k = k_i\alpha + k_m(1-\alpha)$, where k is the observed second-order rate constant, k_i and k_m are rate constants for the reactions of ions and ion pairs, respectively, and α is the degree of dissociation, it is generally assumed that k_i and k_m are independent of the ionic strength. Second-order specific rates, k, for the exchange of ^{131}I between methyl iodide and alkali iodides (NaI, KI, RbI, and CsI, respectively) in methanol at 25°C, where these salts are associated to only a few per cent, decrease with increasing ionic strength. It is shown that this change is due to kinetic salt effects (changes in activity coefficients of reactants and transition-state complex with ionic strength) as well as changes in ionic association and different reactivities of free and paired ions. For the range of concentration of ionic halide investigated, $2 \times 10^{-4} - 8 \times 10^{-3}$ M, the reaction of free halide ions is subject to a negative salt effect of between 3 and 4%. A necessary consequence of the Acree hypothesis is that k_i should be independent of the nature of the cation. It is verified that this is so; the rate constants, k_i, for those exchanges in which NaI, KI, RbI, and CsI, respectively, are involved are in the ratios, 1.001 : 1.005 : 0.998 : 0.995. The degree of association is too insignificant to permit quantitative conclusions concerning the reactivity of paired ions, though the data do not exclude a contribution of ion pairs to the reaction rate. (auth)

41268 SOLVOLYSIS REACTIVITIES OF ETHYL AND N-PROPYL TRIFLUOROMETHANESULPHONATES IN TRIFLUOROETHANOL AND TRIFLUOROACETIC ACID. Dafforn, G. A. Streitwieser, A. Tetrahedron Lett.: No. 36, 3159-62(Aug 1970).

The solvolysis rates of ethyl and n-propyl trifluoromethanesulphonates in trifluoroacetic acid (TFA), trifluoroethanol (TFE), and acetic acid were determined titrimetrically. Experimental detail is given and the results tabulated and discussed. The small deuterium isotope effects in TFA and TFE suggested that ethyl trifluoromethanesulphonate solvolyzes with little limiting character in either solvent, whereas the large rate enhancement of propyl trifluoromethanesulphonate relative to ethyl and the formation of isopropyl TFA indicated limiting solvolysis with concerted hydrogen migration. The nucleophilicity of TFE is discussed and was found to lie between TFA and acetic acid. Results showed that normal solvolyses of primary alkyl systems involve exclusively participation by solvent or by an external or internal (neighboring group) nucleophile; primary carbonium ions are not involved. (UK)

41269 ATOMIC WEIGHTS OF THE ELEMENTS 1969. Pure Appl. Chem.; 21: 91-108(1970).

A historical discussion is given. Variations in isotopic composition and the systematic treatment of uncertainties in atomic weights are considered. The revised atomic weights of lithium, rubidium, and lead based on new experimental work are given. Other recommended changes in the atomic weight table due to either decreased apparent precision or increased precision are discussed. ^{99}Tc, ^{226}Ra, ^{231}Pa, and ^{237}Np are now listed and new techniques for the determination of atomic weights considered. Tables of atomic weights in alphabetical order, atomic weights in order of atomic number based on the assigned relative atomic mass $^{12}C = 12$, selected radioisotopes in order of their atomic number, and the atomic masses of these isotopes are given. (UK)

41270 A PROCESS FOR THE PRODUCTION OF TETRA-AMMONIUM-DIOXOTRICARBONATE URANATE. (to NUKEM-Nuklear-Chemie und-Metallurgie Gesellschaft mbH). British Patent 1,201,356. 5 Aug 1970. Priority date 17 Dec 1966, Germany.

A process is described for the conversion of UF_6 into the ammonium uranyl carbonate complex of the composition $(NH_4)_4[UO_2(CO_3)_3]$, which is suitable for conversion into a highly pure UO_2 that flows freely and may be readily sintered. The complex is precipitated by the simultaneous introduction of UF_6 vapors and gaseous or pressure-liquefied NH_3 and CO_2 into water or recycled precipitation solution. The pH of the solution is maintained from 7.8 to 8.6. (B.L.M.)

41271 CURIUM HYDRIDE. Bansal, B. M.; Damien, D. (CEN, Fontenay-aux-Roses, France). Inorg. Nucl. Chem. Lett.; 6: 603-6(Jul 1970).

The preparation and crystallographic characterization of a curium hydride of unestablished composition, but presumably representable as CmH_{2+x}, are reported. The CmH_{2+x} phase is face centered cubic, similar to the corresponding neptunium, plutonium, and americium hydrides and with most of the rare earth dihydrides. (UK)

41272 CHEMISTRY OF RARE EARTHS IN MOLTEN ALKALI METAL CHLORIDES. II. MELTING OF ALKALI METAL CHLORIDES WITH THE LANTHANIDE CHLORIDES $PrCl_3$ TO $YbCl_3$. Foerthmann, R. (Kernforschungsanlage, Juelich, Ger.); Schneider, A. Z. Anorg. Allg. Chem.; 367: 27-33(May 1969). (In German).

Measurements of the electric conductivity in molten mixtures of different rare earth chlorides and potassium or sodium chloride pointed out not only the existence of $LnCl_6^{3-}$ (Ln = Pr, Nd, Sm, Gd, Dy, Er, Yb) in all these melts, but also the formation of species like $Sm_2Cl_7^-$ or $Dy_3Cl_{10}^-$ in the lanthanide–sodium chloride systems. In analogy to the rare earths, trivalent uranium formed UCl_6^{3-} in molten sodium chloride. The specific electrical conductivities of pure molten rare earth chlorides at 800 and 900°C are reported. (auth)

41273 ISOTOPE EFFECTS IN AUTOXIDATION. V. ON THE DEPENDENCE OF THE MAGNITUDE OF KINETIC ISOTOPE EFFECTS UPON THE RELATIVE DEUTERIUM CONTENT. Rummel, S.; Krumbiegel, P.; Huebner, H. (Institut fuer Stabile Isotope, Leipzig). Isotopenpraxis; 6: 134-7(Apr 1970). (In German).

Mixtures of cumene and cumene-d were used to study the dependence of different oxidation characteristics upon the relative deuterium content. The all reaction rate, the rate of chain propagation reaction, and the length of the induction period showed a nonlinear dependence upon the deuterium content. Results are discussed. (auth)

41274 REACTION OF URANYL ION WITH PROPIONALDEHYDE IN THE PRESENCE AND ABSENCE OF LIGHT. Haas, R. M.; Gayer, K. H. (Wayne State Univ., Detroit). Z. Anorg. Allg. Chem.; 367: 102-12(May 1969).

A study was made of the photochemical reduction of the uranyl ion by propionaldehyde in aqueous and nonaqueous media. The products of the photochemical reaction in propionaldehyde solution enter into a reverse reaction following an induction period. Products formed in aqueous media apparently enter into some reaction which prevent them from undergoing a reverse reaction. Conductivity measurements of solutions of $UO_2(NO_3)_2 \cdot 6\,H_2O$ in propionaldehyde, indicate that dissociation of the uranyl salt occurs. The rate equations for the formation and disappearance of uranous ion in propionaldehyde are discussed. The probable mechanisms for

the forward and reverse reactions in terms of only those species which change oxidation states are: Forward: U(VI) + (R) + $h\nu$ → U(V) + (O); 2 U(V) + acid → U(IV) + U(VI) + Products, and Reverse: U(IV) + (O) → U(V) + (R); 2 U(V) + acid → U(VI) + U(IV) + Products. The symbols (R) and (O) refer to the reduced and oxidized forms respectively. The overall quantum yield for the U(VI) to U(IV) reaction was found to be at least 0.72. (auth)

41275 HOMOGENEOUS HYDROGENATION OF SUBSTITUTED CINNAMIC ACIDS WITH PENTACYANOCOBALTATE(II). Basters, J.; Van Bekkum, H.; Van Reijen, L. L. (Technische Hogeschool, Delft, Netherlands). Rec. Trav. Chim.; 89: 491-9(May 1970).

The homogeneous hydrogenation of a series of substituted trans-cinnamic acids with pentacyanocobaltate(II)-ion was investigated. The reactions were found to be first order in pentacyanohydridocobaltate(III) as well as in substrate, and zero order in cyanide. Electronic substituent effects may be expressed in terms of a Hammett–Yukawa relationship with $\rho = 0.67$. In the hydrogenation of cis-cinnamic acid partial isomerization to the trans-isomer was observed. The deuteration of cis- and trans-cinnamic acid and the hydrogenation of α,β-dideutero-cis-cinnamic acid were studied. The results can be understood by considering the reaction as a stepwise hydrogen atom transfer from the hydride to the substrate. (auth)

41276 PHASE DIAGRAM OF THE SYSTEM URANIUM–OXYGEN–FLUORINE. Knacke, O.; Lossmann, G.; Mueller, F. (Technische Hochschule, Aachen. Kernforschungsanlage GmbH, Juelich, Ger.). Z. Anorg. Allg. Chem.; 370: 91-103(Oct 1969). (In German).

Phase diagrams including the compounds $UO_2-U_4O_9-U_3O_8-UO_3-UO_2F_2-UF_3-UF_4-UF_{4.25}-UF_{4.5}-UF_5-UF_6$ are calculated with the coordinates of temperature and partial pressure of O_2, F_2 and UF_6, respectively. On the basis of these diagrams experimental equilibrium investigations are discussed as well as some technical fluorination reactions. (auth)

41277 INFRARED SPECTROSCOPIC INVESTIGATIONS ON THE LIQUID SYSTEMS SO_3-H_2O AND SO_3-D_2O. IV. INFRARED SPECTRA AND COMPOSITION OF THE LIQUID SYSTEMS $D_2O-D_2SO_4$ AS WELL AS $D_2SO_4-SO_3$. Stopperka, K. (Technische Univ., Dresden). Z. Anorg. Allg. Chem.; 370: 80-90(Oct 1969). (In German).

The ir spectra of 5 to 100% D_2SO_4, taken between silicon windows, resemble those of the system $H_2O-H_2SO_4$ (D_2O, $(D_2O)_5$, DSO_4^-, D_3O^+, and D_2SO_4 being the species). According to the ir spectra of the liquid system $D_2SO_4-SO_3$, there are the molecules D_2SO_4, $D_2S_2O_7$, $D_2S_3O_{10}$, SO_3, and S_3O_9, but no indication for $DS_2O_7^-$ and $D_3SO_4^+$ ions found as the corresponding species in the system $H_2SO_4-SO_3$. (auth)

41278 GASEOUS METAL BORIDES. II. MASS-SPECTROMETRIC EVIDENCE FOR THE MOLECULES UB_2, UB, AND CeB AND PREDICTED STABILITY OF GASEOUS DIBORIDES OF ELECTROPOSITIVE TRANSITION METALS. Gingerich, Karl A. (Texas A and M Univ., College Station). J. Chem. Phys.; 53: 746-8(15 Jul 1970).

A combination of Knudsen effusion and mass-spectrometric techniques were used for the investigation of the reactions (1) $UB_2(g) + 2C(g) = UC_2(g) + 2B(g)$, (2) $UB(g) + C(g) = UC(g) + B(g)$, and (3) $CeB(g) = Ce(g) + B(g)$. The experimental third-law enthalpies were combined with appropriate literature data to obtain the following dissociation energies or heats of atomization, D_0°, in kilocalories/mole: UB, 76 ± 8; CeB, 72 ± 5; and UB_2, 227 ± 10. The Pauling model of a strongly polar $M-B_2$ bond was used to estimate the heats of atomization of gaseous diborides of selected electropositive transition metals. (auth)

41279 ABOUT SOME STRUCTURAL DIFFERENCES OF CERTAIN INORGANIC SALT SOLUTIONS IN NATURAL AND HEAVY WATER. Selecki, A.; Tyminski, B.; Chmielewski, A. G. (Warsaw Technical Univ.). Isotopenpraxis; 6: 138-42(Apr 1970).

On the basis of viscosity measurements of seven electrolyte solutions (KCl, KBr, KI, LiCl, Na_2CO_3, Li_2SO_4, and $MnSO_4$) in heavy water and the viscosity data of four electrolyte solutions (KCl, KBr, KI, and Na_2CO_3) in ordinary water, the activation energies of viscosity were determined from the Pantchenkov equation. The determinations were made at 25, 35, 45, 60, 75, and 90°C, at various concentrations up to near saturation. The activation energies of viscosity for pure heavy and ordinary water were determined too. The results allowed conclusions on the various influences of the investigated salts on the structure of heavy and ordinary water. (auth)

41280 URANIUM NITRIDE CHLORIDES, BROMIDES, AND IODIDES. Juza, R.; Meyer, W. (Christian-Albrechts Univ., Kiel). Z. Anorg. Allg. Chem.; 366: 43-5(Apr 1969). (In German).

The nitride halides UNCl, UNBr, and UNI were prepared by heating the tetrahalides in a current of ammonia, as well as by reaction of the tetrahalides with uranium nitride. The compounds were characterized by analysis and their chemical and physical properties. The compounds are isotypic with BiOCl (EO_1-type), they are, in addition, structurally related to the corresponding thorium compounds. (auth)

41281 THERMAL DISSOCIATION AND SUBLIMATION OF UO_2F_2. Knacke, O.; Lossmann, G.; Mueller, F. (Technische Hochschule, Aachen. Kernforschungsanlage GmbH, Juelich, Ger.). Z. Anorg. Allg. Chem.; 371: 32-7(Dec 1969). (In German).

The thermal dissociation $3UO_2F_2 = \frac{2}{3}U_3O_8 + UF_6 + \frac{1}{3}O_2$ was investigated between 760 and 800°C by the Knudsen effusion method. From the amount of uranium oxide formed during the reaction, the dissociation constant was calculated to be $4.575 \log K = 90740/T + 62.36$. Besides dissociation, evaporation of UO_2F_2 takes place with a vapor pressure of the order 0.01 to 0.1 torr in the temperature range investigated. (auth)

41282 ^{18}O TRACER STUDY OF U(IV)–U(VI) ELECTRON EXCHANGE REACTION. Kato, Yasuyoshi (Tokyo Inst. of Tech.); Suzuki, Kazunori; Fukutomi, Hiroshi; Tomiyasu, Hiroshi; Gordon, Gilbert. Bull. Tokyo Inst. Technol. (Engl. Ed.); No. 96, 133-6 (Mar 1970).

Results have been published on the electron exchange reaction between U(IV) and U(VI). Results obtained in the oxygen exchange between uranium ion and water during the electron exchange reaction are reported. (auth) (Japan)

41283 AMMONIATES AND AMMONOLYSIS OF URANIUM TETRACHLORIDE. Berthold, H. J.; Knecht, H. (Institut fuer Anorganische Chemie und Kernchemie, Mainz). Z. Anorg. Allg. Chem.; 366: 249-64(May 1969). (In German).

UCl_4 reacted with liquid or gaseous NH_3 under atmospheric pressure to form ammoniates, which after removal of excess ammonia at room temperature contained 7.3 to 7.5 moles of NH_3 per mole of UCl_4. Reactions of liquid NH_3 under pressure at room temperature yielded ammoniates with 9 to 10 moles of NH_3. Also, a slight ammonolysis in liquid ammonia occurred. Isothermal decomposition of the ammoniates in a stream of nitrogen at 45°C led to $UCl_4 \cdot 4NH_3$, which at higher temperatures decomposed into $UCl_4 \cdot 1NH_3$ (stable up to about 300°C). The reaction of the higher ammoniates with gaseous carbon dioxide showed that coordinatively bound NH_3 can be distinguished from "structural ammonia." Above 350°C in a stream of ammonia, UCl_4 and its ammoniates underwent ammonolyses, forming amorphous uranium(IV) amidochloride, UNH_2Cl_3. This compound was then reduced to UCl_3 which underwent further ammonolysis via amorphous amidochlorides $[UNH_2Cl_2$, $U(NH_2)_2Cl]$ and crystalline uranium imidechloride U(NH)Cl to pure higher uranium nitride, UN_x ($x \leq 1.75$) (at 800°C). (auth)

41284 LEAD URANIUM OXYFLUORIDE WITH MONOVALENT METALS. Kemmler-Sack, S. (Laboratorium fuer Anorganische und Analytische Chemie, Tuebingen, Ger.). Z. Anorg. Allg. Chem.; 364: 135-47(Jan 1969). (In German).

The compound $Pb_2U_2O_7$ reacts with $NaUO_3F$ solid solutions up to the composition $Pb_2U_2O_7 \cdot NaUO_3F$. Further, the cubic compounds $A'_{0.33}PbU_2O_{5.67}F$ with A' = K, Rb, Tl and $a = 11.1_0$ Å are reported. According to magnetic and spectroscopic measurements, there are UO_2^{2+} groups present in all compounds prepared. The crystal structures are discussed on the basis of the $CaUO_4$ and $BaUO_4$ type, respectively. (auth)

41285 MAGNETIC AND SPECTROSCOPIC PROPERTIES OF URANIUM OXIDE FLUORIDES AND THEIR STRUCTURAL RELATIONSHIP TO THE URANIUM OXIDES. Kemmler-Sack, S. (Laboratorium fuer Anorganische und Analytische Chemie, Tuebingen, Ger.). Z. Anorg. Allg. Chem.; 364: 88-99(Jan 1969). (In German).

The magnetic and optical properties of the uranium oxyfluoride phases with those of U(V) or U(V) and U(VI), respectively, are reported. There are strong structural relationships between the four phases and the structures of some uranium oxides in the range U_3O_5 to UO_3. The oxides as well as the oxyfluorides contain O–U–O-chains (ligand field symmetry $D_{\infty h}$). (auth)

41286 STUDY OF THE VIBRATIONAL SPECTRA OF THE ADDITION COMPOUNDS $(CH_3)_2SO-{}^{10}BF_3$, $(CH_3)_2SO-{}^{11}BF_3$, $(CD_3)_2SO-{}^{10}BF_3$, AND $(CD_3)_2SO-{}^{11}BF_3$. Forel, M.-T.; Tranquille, M.; Fouassier, M. (CNRS, Talence, France). Spectrochim. Acta, Part A; 26: 1777-89(Aug 1970). (In French).

Infrared and Raman spectra of four co-ordination compounds

(DMSO–$^{10}BF_3$, DMSO–$^{11}BF_3$, DMSO-d_6–$^{10}BF_3$, and DMSO-d_6–$^{11}BF_3$) were recorded from 20 to 4000 cm^{-1} for the first time. An assignment is proposed based upon isotopic shifts and polarizations of the Raman lines. The force constant of the coordination bond is estimated and the normal modes of vibration of the OBF_3 group are discussed. (auth) (UK)

41287 STUDY OF THE VIBRATIONAL SPECTRA OF THE ADDITION COMPOUNDS $(CH_3)_2CO$–$^{11}BF_3$, $(CH_3)_2CO$–$^{10}BF_3$, $(CD_3)_2CO$–$^{11}BF_3$, AND $(CD_3)_2CO$–$^{10}BF_3$. Forel, M.-T.; Fouassier, M.; Tranquille, M. (CNRS, Talence, France). Spectrochim. Acta, Part A; 26: 1761-75(Aug 1970). (In French).

Infrared spectra of four coordination compounds $(CH_3)_2CO^{11}BF_3$, $(CH_3)_2CO^{10}BF_3$, $(CD_3)_2CO^{11}BF_3$, and $(CD_3)_2CO^{10}BF_3$ were recorded. An assignment was made based upon isotopic shifts and comparison with vibrational spectra of free acetone and acetone-d_6. A structure is proposed for the complex. The force constant of the coordination was estimated and the normal modes of vibration of various XBF_3 groups are discussed. (auth) (UK)

41288 OPTICAL STUDY ON THE PHASE TRANSITIONS IN KH_2PO_4 AND KD_2PO_4. Sato, Yoshiki (Japan Atomic Energy Research Inst., Tokai). J. Chem. Phys.; 53: 887-92(1 Aug 1970).

The infrared spectra of the PO_4 stretching vibrations were studied on KH_2PO_4 and KD_2PO_4 over a wide range of temperature. A trend of the intensity variation with temperature for these bands is similar in each compound, but is very different between both compounds. An inspection of the intensity behaviors indicates that each PO_4 group is attached equivalently by four hydrogen atoms in KH_2PO_4, and by two deuterium atoms in KD_2PO_4, above the respective transition points. Each of the hydrogen and phosphorus atoms in KH_2PO_4 moves in a single-minimum potential well with a flattened bottom, while each of the corresponding atoms in KD_2PO_4 moves in a double-minimum potential well. Further, nonexistence is evidenced for a Slater configuration connected with an energy parameter ϵ_0 in his model. As a result, it is concluded that the displacive and pseudospin models are the most relevant in describing the phase transition mechanisms in KH_2PO_4 and KD_2PO_4, respectively. (auth)

41289 CHEMICAL ACCELERATOR STUDIES OF ISOTOPE EFFECTS ON COLLISION DYNAMICS OF ION–MOLECULE REACTIONS: ELABORATION OF A MODEL FOR DIRECT REACTIONS. Hierl, P. M.; Herman, Z.; Wolfgang, R. (Univ. of Colorado, Boulder). J. Chem. Phys.; 53: 660-73(15 Jul 1970).

Crossed-beam studies on isotopic variants of the reaction $Ar^+ + H_2 \rightarrow ArH^+$ are reported. Both velocity and angular distributions of the ionic product as a function of initial translational energy, down to 0.1 eV (center of mass), were measured. At lowest energies there is a gain in the translational energy of the products over that of the reactants, but at higher energies there is increasing conversion of kinetic into internal energy. While this represents the most probable course of the reaction there is a fairly wide distribution about the median values. Results confirm that this reaction is predominantly direct at all energies and provide no evidence for intermediate persistent complex formation. They are also consistent with a model for direct reactions previously proposed. The data on reaction with HD permit further development of this mechanism. The reactants are mutually accelerated by their long-range attractive potential until hydrogen atom transfer occurs. The liberated H (or D) atom is reflected from the $ArD^+(ArH^+)$ and the products separate, being decelerated in the process by the attractive potential acting between them. This "polarization-reflection" model yields a reasonable value for the radius at which transfer occurs, and it accounts quantitatively for the magnitudes of, and isotopic effects on, the median product velocities. It also predicts the significant back scattering observed at very low as well as very high energies. With appropriate modification for the attractive potentials involved the model can provide a simple representation of direct reactions in general. (auth)

41290 INFRARED SPECTRA IN POLARIZED LIGHT OF CRYSTALLINE BENZENE AND BENZENE-d_6. Marzocchi, M. P.; Bonadeo, H.; Taddei, G. (Univ., Florence). J. Chem. Phys.; 53: 867-75(1 Aug 1970).

The high-resolution spectra in polarized light of oriented polycrystalline films of C_6H_6 and C_6D_6 at 85°K were obtained. The observation of two different crystal faces allowed the classification of the Davydov components, according to their polarization character, into three different sets, which correspond to the three infrared-active factor-group symmetry species. The complications that arise from the presence of isotopic impurities ($^{13}C^{12}C_5H_6$ in $^{12}C_6H_6$, $^{13}C^{12}C_5D_6$ and $^{13}C_6D_5H$ in $^{12}C_6D_6$) are removed thanks to the use of polarized light, the aid of the correlation between C_6H_6 and C_6D_6 spectra, and solid solution information. Therefore, a complete assignment of all the observed peaks was possible. The experimental results were compared with exciton splittings and crystal shifts calculated by others. (auth)

41291 HYDROGEN–DEUTERIUM ISOTOPE EFFECTS IN NQR SPECTROSCOPY. Brill, T. B.; Hugus, Z. Z. Jr. (North Carolina State Univ., Raleigh). J. Chem. Phys.; 53: 1291-2 (1 Aug 1970).

The ^{123}Sb resonance frequencies in the trigonal bipyramidal molecules $(CH_3)_2SbX_3$ and $(CD_3)_2SbX_3$, where X = Cl and Br, were observed to increase in going from H to D. (M.C.G.)

41292 STUDY OF THE DENSITY VARIATION OF WATER AS A FUNCTION OF ITS ISOTOPIC COMPOSITION. Menache, Maurice (Institut Oceanographique, Paris); Girard, Georges. Compt. Rend., Ser. B; 270: 1513-16(15 Jun 1970). (In French).

Measurements of the density variation as a function of isotopic composition were made for water samples at 0.02 kg m^{-3} density intervals; the results enabled a more precise law than was previously available to be established. (auth) (France)

41293 REACTIONS OF $C_2H_6^+$: FORMATION OF THE $(C_2H_6)_2^+$ ION. Searles, S. K.; Sieck, L. Wayne; Ausloos, P. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys.: 53: 849-50(15 Jul 1970).

Ions formed in C_2H_6 and CH_3CD_3 under the same conditions of argon resonance radiation (11.6–11.8 eV) were investigated. Results indicated that there is an isotope effect favoring loss of CD_3 groups over CH_3. (M.C.G.)

41294 STRUCTURE OF AQUOCOMPLEXES OF URANIUM(IV). Glebov, V. A.; Knyazev, Yu. D.; Lekae, V. A.; Borodina, N. N. Zh. Neorg. Khim.; 15: 1332-5(May 1970). (In Russian).

The spin echo method was used to measure the temperature relation of the longitudinal relaxation of protons in solutions of uranium(IV). From analysis of the relation, conclusions were drawn concerning the inequality of water molecules in aquo complexes of U(IV); part of the water molecules were more stably connected to the ion than the other. The activation energy and the lifetime of stably connected molecules of water in the first coordination sphere of uranium were determined. On the basis of data obtained and calculation of packing density of aquo complexes, the structure of aquo complexes of uranium(IV) with two unequal water molecules is proposed. (tr-auth)

41295 ISOTOPE EXCHANGE AT EQUILIBRIUM AS A TEST FOR HOMOTROPIC COOPERATIVITY OF ALLOSTERIC ENZYMES. Engers, H. D.; Bridger, W. A.; Madsen, N. B. (Univ. of Alberta, Edmonton). Biochemistry; 9: 3281-4(4 Aug 1970).

The appearance of sigmoid velocity vs substrate concentration curves with regulatory enzymes can be interpreted in terms of models involving cooperativity among substrate binding sites. There are, however, certain circumstances that can lead to apparent sigmoid kinetic plots in the absence of homotropic cooperativity. One such possibility arises with enzymes exhibiting rapid equilibrium random mechanisms. If an inhibitor were to exert its effects by changing the rates of association and dissociation of substrates, the rapid equilibrium condition might no longer apply in its presence. As a result, the hyperbolic velocity vs substrate concentration plot obtained in the absence of inhibitor could approach a sigmoid curve in its presence, with no requirement for site-site interaction. A simple test for such a possibility involves measurement of the kinetics of isotope exchange at chemical equilibrium in the presence and absence of modifier. The effect of glucose on the kinetics of isotope exchange for phosphorylase a, and the effect of adenosine triphosphate on the same properties of phosphorylase b, were examined. (M.C.G.)

41296 EFFECTS OF DIFLUORODICHLOROMETHANE ON METAL OXIDES. Pausewang, G.; Ruedorff, W. (Univ., Tuebingen, Ger.). Z. Anorg. Allg. Chem.; 369: 89-104(Oct 1969). (In German).

The reactions of CCl_2F_2 with metal oxides or carbonates between 450 and 800°C leads either to the corresponding fluorides or to the chlorides. High purity anhydrous fluorides of Mg, Al, the rare earths, Zr, Th, and U have been obtained quantitatively by this way. Replacement of the oxides of these metals by their chlorides yields the fluorides, too. Nb_2O_5 and Ta_2O_5 react to give the oxide fluorides. The oxides of Cr, Fe, Ru, Co, Ni, Cu, Zn, Cd, Hg and Ga form only the corresponding chlorides, whereas those of Mo, W, Re, and Bi mainly lead to oxide chlorides. Fluoride chlorides result from the reaction with $SrCO_3$, $BaCO_3$ and PbO. Mixtures of different compounds were only found in the case of Li, Tl, Ti, V, Sb, Mo, and W. Carbon-containing reaction products are $COCl_2$, CCl_4, C_2Cl_6, C_2Cl_4, and CO_2, if metal

fluorides, and CF_4, $CClF_3$, and $COCl_2$, if metal chlorides are formed. By means of thermodynamic data an explanation is offered for the fact that some metal oxides are fluorinated by Freon, and others chlorinated. (auth)

41297 SOME APPROACHES TO THE SYNTHESIS OF AMINOCYCLOPROPANE THIOLS AND AMINOCYCLOBUTANE THIOLS. Stewart, Wilford Seabrook. Washington, D. C.; Howard Univ. (1969). 99p.

Thesis.

The synthesis of the following compounds: cis-2-aminocyclopropanethiol, trans-2-aminocyclopropanethiol, cis-2-aminocyclopropylmethanethiol, cis-2-aminocyclobutanethiol, trans-2-aminocyclobutanethiol, and trans-2-aminocyclobutylmethanethiol was studied. The fused ring nature of these compounds and the existence of cis-trans isomers might shed considerable light on the mechanism of protection against ionizing radiation and the stereospecific requirements for that protection. (TSS)

41298 VIBRATIONALLY EXCITED METHYL CHLORIDE. II. REACTIONS OF VIBRATIONALLY HOT BUT TRANSLATIONALLY COLD METHYL CHLORIDE. Baer, Tomas; Bauer, S. H. (Cornell Univ., Ithaca, N. Y.). J. Amer. Chem. Soc.; 92: 4773-84(12 Aug 1970).

The highly exothermic gas-phase reaction A ($HCl + CH_3N_2 \rightarrow CH_3Cl^* + N_2$ ($\Delta H^0 \approx -68$ kcal mole^{-1})) was used to produce vibrationally hot but translationally cold methyl chloride. Tracer studies with the deuterated acid showed that the rate of reaction B ($DCl + CH_3N_2 \rightleftharpoons CHDN_2 + HCl$) was comparable to that of reaction A. However, analysis showed that reactions A and B by themselves cannot account for the distribution of D in the product methyl chloride, $CH_{3-n}D_nCl$ (n = 0-3). It is necessary to introduce an exchange step ($DCl + CH_3DCl^* \rightleftharpoons CHD_2Cl^* + HCl$) between hot methyl chloride and DCl. Evidence for a similar reaction between hot methyl chloride and D_2O was also uncovered ($D_2O + CH_3DCl^* \rightleftharpoons CHD_2Cl^* + HDO$). Along with these experimental results, a discussion of the significance of these observations with respect to the vibrational excitation mechanism for homogeneous atom switching is presented. (auth)

41299 BIS(CYCLOOCTATETRAENYL)NEPTUNIUM(IV) AND BIS(CYCLOOCTATETRAENYL)PLUTONIUM(IV). Karraker, D. G.; Stone, J. A.; Jones, E. R. Jr.; Edelstein, N. (E. I. du Pont de Nemours and Co., Aiken, S. C. Univ. of California, Berkeley). Contract AT(07-2)-1. J. Amer. Chem. Soc.; 92: 4841-5 (12 Aug 1970).

$Np(COT)_2$ and $Pu(COT)_2$ ($COT = C_8H_8^{2-}$) were prepared by the reaction in tetrahydrofuran(THF) solution of K_2COT with $NpCl_4$ and $[(C_2H_5)_4N]_2PuCl_6$, respectively. Infrared spectra of both were consistent with D_{8h} molecular symmetry ("sandwich" compounds), and x-ray diffraction patterns showed both to be isomorphous with $U(COT)_2$. The isomer shift of the Mössbauer spectrum of $Np(COT)_2$ was unusually positive for a Np^{4+} compound, indicating an electron contribution from the ligand to the bonding. The magnetic moments measured between 4.2 and 44°K were 2.43 BM for $U(COT)_2$ and 1.81 BM for $Np(COT)_2$; $Pu(COT)_2$ was diamagnetic. A crystal-field model with an orbital reduction factor, k, of 0.8 is in reasonable agreement with the experimental results. (auth)

41300 STEREOCHEMISTRY AND SECONDARY DEUTERIUM KINETIC ISOTOPE EFFECTS IN THE CYCLOADDITIONS OF DIPHENYLKETENE WITH STYRENE AND DEUTERIOSTYRENES. Baldwin, John E.; Kapecki, Jon A. (Univ. of Illinois, Urbana, Univ. of Oregon, Eugene). J. Amer. Chem. Soc.; 92: 4874-9 (12 Aug 1970).

The concerted (2 + 2) cycloaddition between styrene and diphenylketene is highly stereoselective: cis-β- deuteriostyrene leads to the 2,2,3-triphenyl-4-deuteriocyclobutanone having cyclobutyl hydrogens in a cis relationship. Secondary deuterium kinetic isotope effects for the reaction are (k_H/k_D) = 0.91 at the β position and (k_H/k_D) = 1.23 at the α position of styrene at 65°. (auth)

41301 PHOTOCHEMICAL REACTIONS. LIX. ON THE MECHANISM OF THE PHOTODECARBONYLATION OF β, γ-UNSATURATED ALDEHYDES. Baggiolini, E.; Hamlow, H. P.; Schaffner, K. (Technische Hochschule, Zurich). J. Amer. Chem. Soc.; 92: 4906-21(12 Aug 1970).

Irradiation in the long-wavelength absorption bands of the β, γ-unsaturated aldehydes in various solvents results exclusively in decarbonylation from the singlet excited state. Fluorescence and singlet-triplet intersystem crossing have not been found to participate at the dissipation of excitation energy. The decarbonylation involves elimination of carbon monoxide and concurrent intramolecular transfer of the aldehydic hydrogen go the α- and γ-carbons, with the transfer to the α position dominating in all aldehydes. An isotope effect of ca 1.1 : 1 for the rates of decarbonylation of laurolenal is observed. Added tri-n-butylstannane is capable of effecting both competition between intramolecular hydrogen transfer and incorporation of stannane hydrogen in the decarbonylation process, and competition between decarbonylation and reduction of the singlet excited aldehydes to the corresponding alcohols. The quantum yields for decarbonylation of the aldehydes are solvent dependent, averaging ca 0.5. In t-butyl alcohol, the values are independent of wavelength ($\phi_{CO}^{2976} \approx \phi_{CO}^{3130}$), but they exhibit wavelength-dependent variations in apolar solvents ($\phi_{CO}^{2976} < \phi_{CO}^{3130}$). Wavelength dependencies are also observed for the ratio of intramolecular hydrogen transfer to the α- and γ-carbons (α/γ at 2804 Å > α/γ at 3341 Å), and of the extent of incorporation of stannane hydrogen (incorporation at 2804 Å > incorporation at 3341 Å) in the decarbonylation process. While a concerted process is not excluded for the major decarbonylation path, the intramolecular hydrogen transfer to the α-carbon, α cleavage of the aldehydic rotamers to individual ally-formyl radical-pair intermediates as the primary photochemical process is seen to account for the entire reaction pattern. The secondary reactions of these postulated radical pairs would depend on the incipient orientation of the radical partners within as preformed in their rotameric aldehyde precursors. Conformations associated in the aldehydes with homoconjugation and unimolecular photodecarbonylation are not possible in the bridged aldehyde. The photoexcited compound does not decarbonylate, but rather shows preference for singlet-triplet intersystem crossing and reactions from the triplet state—photoreduction to alcohol and homologization to the corresponding methyl and ethyl ketones (in pentane), a novel photochemical aldehyde transformation. (auth)

41302 STUDIES IN SULFATE ESTERS. V. THE MECHANISM OF HYDROLYSIS OF PHENYL PHOSPHOSULFATE, A MODEL SYSTEM FOR 3'-PHOSPHOADENOSINE 5'-PHOSPHOSULFATE. Benkovic, S. J.; Hevey, R. C. (Pennsylvania State Univ., University Park). J. Amer. Chem. Soc.; 92: 4971-7(12 Aug 1970).

Phenyl phosphosulfate was synthesized as a model for 3'-phosphoadenosine 5'-phosphosulfate PAPS and adenosine 5'-phosphosulfate. The pH-rate profile for the nonenzymic hydrolysis of the analog indicated the dianion and monoanion to be hydrolytically labile. Hydrolysis of the monoanion was viewed as an acid-catalyzed unimolecular mechanism with elimination of sulfur trioxide on the basis of predominant S-O bond cleavage, the small negative value of $\Delta S^{\ddagger}$, the sulfating properties of the monoanion in mixed alcohol-water solvents, and a deuterium oxide solvent isotope effect typical of an A-1 mechanism. A comparison with the mechanistic mode of hydrolysis of acetyl sulfate was developed in order to delineate the unique characteristics of the phosphosulfate bond. These results were interpreted with regard to the significance of the structure which evolved biologically to transport active sulfate. (auth)

41303 ELECTRON SPIN RESONANCE INVESTIGATION OF COPPER FORMATE TETRAHYDRATE AND TETRADEUTEROHYDRATE. Polaczek, A.; Stojek, Z. (Univ. of Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 18: 209-12(1970).

The dependence of the spectroscopic splitting factor g upon the magnetic field direction on rotation in the ac plane was studied. Curves for both $Cu(HCOO)_2 \cdot 4H_2O$ and $Cu(HCOO)_2 \cdot D_2O$ fit within the limits of error. The effect of temperature on the ESR signal of a $Cu(HCOO) \cdot 4D_2O$ monocrystal was studied. (J.G.B.)

41304 HYDROGEN ISOTOPIC EXCHANGE IN FIVE-MEMBERED AROMATIC HETEROCYCLES. III. FURAN, THIOPHENE, PYRROLE, N-METHYLPYRROLE AND ITS BENZOLOGUES. Zatsepina, N. N.; Kaminskii, Yu. L.; Tupitsyn, I. F. (State Inst. of Applied Chemistry, Leningrad). Reakts. Sposobnost Org. Soedin., Tartu. Gos, Univ.; 6: 753-65(Oct 1969). (In Russian).

The kinetics of aromatic CH bond deuterium exchange in five-membered heterocyclics with one heteroatom was studied in 0.75n $C_2H_5OK + C_2H_5OD$. The "phenide" model of transition state (A) proved to be valid for quantum-chemical calculation of conjugation influence on the reaction studied. A comparison of the relative exchange rate of α-CH bonds in analogous oxygen and sulfur compounds revealed d-orbital stabilization of aliphatic carbanions to be more essential than aromatic ones. Unlike N-CH_3 derivatives, the deuterium exchange in compounds with acidic NH groups (pyrrole, indole) proceeded by the mechanism of electrophilic substitutions in ionized molecules. (auth)

41305 HYDROGEN ISOTOPIC EXCHANGE IN FIVE-MEMBERED AROMATIC HETEROCYCLES. IV. METHYL DERIVATIVES OF FURAN, THIOPHENE, PYRROLE, AND ITS BENZOLOGUES. Zatsepina, N. N.; Tupitsyn, I. F.; Kaminskii, Yu. L.; Kolodina, N. S. (State Ins. of Applied Chemistry,

Leningrad). Reakts. Sposobnost Org. Soedin., Tartu. Gos. Univ.; 6: 766-77(Oct 1969). (In Russian).

The kinetics of deuterium exchange in methyl groups of five-membered heterocycles with one heteroatom and their benzologs were studied in ethanolic potassium ethoxide. Kinetic CH acidity of these compounds was correlated with π-electron density of carbon atom nearest to methyl group, and with π-electron delocalization energy. NMR chemical shifts and infrared intensity of CH stretching vibrations of methyl groups were measured and used for calculation of constants of heteroatomic substituents and the deuterium exchange rate constants. (auth)

41306 HYDROGEN ISOTOPIC EXCHANGE IN FIVE-MEMBERED AROMATIC HETEROCYCLES. V. QUANTITATIVE CHARACTERISTICS OF HETEROATOMS ELECTRONIC EFFECTS. Zatsepina, N. N.; Kaminskii, Yu. L.; Tupitsyn, I. F. (State Inst. of Applied Chemistry, Leningrad). Reakts. Sposobnost Org. Soedin., Tartu. Gos. Univ.; 6: 778-96(Oct 1969). (In Russian).

Available information on reactivity and physical properties of five-membered aromatic heterocycles was analyzed in terms of the Yukava–Tsuno equation. It was concluded that all the groups under consideration are electron-withdrawing as compared with unsubstituted phenyl, if resonance interaction between the heteroatom and a reaction center is absent or negligible. Some deuterium exchange reactions between CH and CH_3 in the aromatic heterocyclic compounds are considered. (M.C.G.)

41307 REACTIONS OF THE U(VI) COMPLEXES OF OXINE. Corsini, A.; Abraham, J. (McMaster Univ., Hamilton, Ont.). Can. J. Chem.; 48: 2360-5(1 Aug 1970).

The interaction of the oxine adduct, $UO_2(C_9H_6NO)_2 \cdot C_9H_6NOH$, and of the bis compound, $UO_2(C_9H_6NO)_2$, with several solvents was studied. The oxine ligand in the adduct is displaced by DMSO but the adduct is stable in solvents of relatively low polarity. The bis compound is unstable and reacts to form both the adduct and solvates. Under appropriate conditions, the addition reaction between the bis compound and a solution of oxine is quantitative. Studies with [^{14}C]-oxine revealed that the addition is accompanied by two exchange reactions. (auth) (Canada)

41308 KINETICS OF THE REACTIONS $CCl_3+H_2(D_2)$ AND $CCl_3+CH_4(CD_4)$. ISOTOPE EFFECT. Hautecloque, Simone (Paris Univ.). J. Chim. Phys.; 67: 771-6(Apr 1970). (In French).

The reactions of trichloromethyl radicals with H_2, D_2, CH_4 and CD_4 investigated. The photolysis of bromotrichloromethane was used as a source of radicals. Using the value observed by De Mare and Huybrechts, for the recombination constant of trichloromethyl radicals, the following values were obtained: $k(CCl_3 + H_2 \rightarrow CCl_3H + H) = 10^{12.7} e^{(-14\,300 \pm 100)/RT}$ cm^3 mole^{-1} s^{-1}; $k(CCl_3 + CH_4 \rightarrow CCl_3H + CH_3) = 10^{13.13} e^{(-21\,600 \pm 600)/RT}$ cm^3 mole^{-1} s^{-1}. The isotope effects observed were in good agreement with these predicted by the activated-complex theory. Calculations were made using Johnston's method. The difference observed between activation energies for the hydrogen abstraction from H_2 and from CH_4 can be explained as a repulsion between the attacking radical and the methane molecule. (auth) (France)

41309 ISOTOPIC EXCHANGE BETWEEN SOME HYDROCARBONS AND MOLECULAR HYDROGEN CATALYZED BY ORGANOALKALINE DERIVATIVES. Baffert-Forges, Gerard; Demarco, Michel; Lambert, Irma; Ravoire, Jean; Dirian, Gregoire (CEN de Saclay, Gif-sur-Yvette, France). J. Chim. Phys.; 67: 1048-50(May 1970). (In French).

Toluene, diphenylmethane, and triphenylmethane, in the presence of their respective organoalkaline derivatives, gave rise to an isotopic exchange in the liquid phase with molecular hydrogen. This exchange did not occur with pentane, methane, benzene, and 1-hexyne. (auth) (France)

41310 VOLATILITY OF PLUTONIUM TETRAFLUORIDE. Chudinov, E. G.; Choporov, D. Ya. At. Energ. (USSR); 28: 151-3(Feb 1970). (In Russian).

In view of the reported instability of plutonium tetrafluoride heated in vacuum, the pressure of saturated PuF_4 vapors was measured at the lowest possible temperatures, using a differential variant of the previously described effusion method. The openings of the nickel diaphragm varied from 6.9×10^{-6} cm^2 to 3.7×10^{-4} cm^2; the amount of plutonium condensed on the target was determined by its α activity. On the basis of the 54 points obtained in 3 series of measurements, the following equation was derived: $\lg P = -(14577.6/T) + 12.1203$ (506 to 852°C). Measurements were also made with the material remaining in the effusion chamber after completing the first 3 series in order to determine the volatility of plutonium fluoride in the decomposition range of the tetrafluoride. It was found that upon heating in vacuum above 1100°C, PuF_4 was completely decomposed into the trifluoride. Previous authors did not measure the vapor pressure of PuF_4 but only that of its decomposition products. Water was found to catalyze the decomposition of PuF_4 into PuF_3. Above 950°C, the pure intermediate product was obtained and therefore there was less scatter of the values in that range than at lower temperatures. (TTT)

41311 LOW FREQUENCY VIBRATIONS OF MOLECULAR CRYSTALS. VIII. THE FAR INFRARED SPECTRUM OF POLYCRYSTALLINE HYDROGEN AND DEUTERIUM CYANIDE. Baglin, F. G.; Coulter, G. L.; Durig, J. R. (Univ. of South Carolina, Columbia). Mol. Cryst.; 10: 47-60(May 1970).

The infrared spectra of crystalline hydrocyanic acid, HCN, and its deuterium analog, DCN, were recorded from 33 to 700 cm^{-1}. Spectral band assignments were made on the basis of the low-temperature crystalline modification, C_{2v}^{12}. A detailed analysis of the effects of the apparently strong hydrogen bond in HCN was carried out on the basis of the dielectric properties of the system. Evidence is offered to show consistency between the $H-C^+=N^-$ resonance structure proposed by Pauling, the high melting point, the low dielectric constant observed by Smyth and McNeight and the pyroelectric effect reported by Dulmage and Lipscomb. (auth) (UK)

Radiation and Nuclear Chemistry

Refer also to abstracts 41756, 41762, 41773, 42298, and 42755.

41312 (COO–1618-17) LABELING OF COMPOUNDS USING THE SZILARD-CHALMERS REACTION. Anselmo, V. C. (New Mexico Highlands Univ., Las Vegas. Dept. of Chemistry). [1970]. 4p. Dep. CFSTI.

A procedure is described for preparing labeled compounds from a Szilard–Chalmers reaction on another but related compound using no chemical synthesis. (auth)

41313 (IJS–252) INSTITUT JOZEF STEFAN, 1949–1969. (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Nov 1969. 78p. (In Slovenian). Dep. CFSTI (U. S. Sales Only).

Research progress is reported in the fields of physics, chemistry, biochemistry, electronics, reactor physics and technology, mathematics, radiation monitoring, and industrial applications of nuclear energy. (M.C.G.)

41314 (ORO–3660-3) MECHANISM OF THE RADIATION INDUCED DECOMPOSITION OF INORGANIC MOLECULAR IONS. Progress Report. Johnson, Everett R. (Maryland Univ., College Park. Dept. of Chemical Engineering). [1969]. Contract AT(40-1)-3660. 5p. Dep. CFSTI.

Progress is reported on a study of the mechanisms of the decomposition of nitrates. Results to date confirm observations made by Cunningham and Kaucic and Maddock; however, the difference in NO_2^- found between the Shinn method and reduction of ceric ion method exist only in the early stages of decomposition, and hence the ratio of NO_2^- found by the two methods approach unity since the difference is constant and does not increase with increasing dose. (D.H.M.)

41315 (RRL–2310-309) ANNUAL REPORT [ON RADIATION RESEARCH], JULY 1, 1969–JUNE 30, 1970. Fundamental Research No. 6041. (Mellon Inst., Pittsburgh, Pa. Radiation Research Labs.). 10 Aug 1970. Contract AT(30-1)-2310. 17p. Dep. CFSTI.

Activities of the Radiation Research Laboratories over the period July 1, 1969 through June 30, 1970 are summarized. These activities include: ESR studies on radiolytic free radicals and H atoms; ion scavenging and recombination processes; radiolysis of aqueous solutions of alkyl halides; and other radiation chemistry studies. (M.C.G.)

41316 (TID–25488) RADIATION EFFECTS IN BIOCHEMISTRY AND ORGANIC CHEMISTRY. Progress Report, October 15, 1967–October 14, 1970. Tolbert, Bert M. [Colorado Univ., Boulder]. [1970]. Contract AT(11-1)-690. 9p. Dep. CFSTI.

Progress is reported on the study of radiation effects in biochemistry and organic chemistry. Work for the past three years was concentrated on the chemical, enzymatic, and conformation effects of ionizing radiation on dry proteins. Topics discussed include: fractionation of irradiated lysozyme by NaCl precipitation and bio gel column chromatography; aggregation of irradiation lysozyme; fractionation of irradiated lysozyme by cation exchange column chromatography; effect of radiation on an enzyme with multiple subunits; a theory of radiation damage to proteins; and future work. (D.H.M.)

41317 (UCRL-19849) RADIATION-INDUCED FREE RADICAL DESTRUCTION. Horan, Paul Karl (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1970. Contract W-7405-eng-48. 95p. Dep. CFSTI.

Thesis.

Free radical production and destruction kinetics were studied. It is shown that destruction is a physical fact and various mechanisms for this destruction are discussed. An attempt was made to identify the mechanism responsible by determining its activation energy. It is demonstrated that more than one process exists and that the electron-hole mechanism is quite possibly one of the processes involved. Evidence is presented that thermally produced electron-holes react with radioinduced organic free radicals. (M.C.G.)

41318 ELECTRON SPIN RESONANCE STUDY OF IRRADIATED POLY-4-METHYLPENT-1-ENE. Whelan, D. J. (Defence Standards Labs., Ascot Vale, Australia); Pinkerton, T. M. Aust. J. Chem.; 23: 391-3(Feb 1970).

The nature of free radicals trapped in γ-irradiated, unstabilized isotactic poly(4-methylpent-1-ene) is reported, for the compound at room temperature and at 77°K. Upon heating to room temperature following irradiation, the free radicals are thought to move from a position on the sidechain, where the most acidic H was lost, to the tertiary carbon atom in the main chain. (Australia)

41319 RADIATION PROTECTIVE AGENTS FOR STORAGE OF ^{131}I-LABELLED L-THYROXINE. Hoeye, Age; Steinnes, Eiliv (Institutt for Atomenergi, Kjeller, Norway). Acta Chem. Scand.; 24: 737-9(1970).

The commercial preparations of L-thyroxine labelled with ^{131}I are usually supplied in aqueous solutions with propylene glycol to protect against radiation decomposition on storage. The radiation protective effect of several other reagents more easily removed are studied and the results summarized in a table. With ethanol, which seems to be a very convenient additive, the best protective effect is obtained in the concentration range 60 to 80%. (Denmark)

41320 ESR STUDY OF INTRAMOLECULAR ENERGY TRANSFER IN THE RADIOLYSIS OF CELLULOSE FUROATES. Singh, Sujan; Hinojosa, Oscar; Arthur, Jett C. Jr. (Dept. of Agriculture, New Orleans). J. Appl. Polym. Sci.; 14: 1591-6(Jun 1970).

The substitution of 2-furoyl, 5-methyl-2-furoyl, 2-furanacryloyl, or 5-bromo-2-furoyl groups on fibrous cotton cellulose increased the radiation resistance of cellulose, as indicated by the retention of strength of the modified fibrous cellulose at high dosages of γ radiation compared with that of irradiated, unmodified fibrous cellulose. The presence of electropositive or electronegative substituents on the furan groups did not significantly change their radioprotective effects for cellulose. Electron spin resonance (ESR) spectra of irradiated celluloses indicated that the long-lived free radical sites were similar, if not the same, in both irradiated, unmodified celluloses. The radioprotective effects of furan groups for cellulose were attributed to absorption of energy from the secondary radiations, primarily the secondary electrons, by the groups due to their π-electron-type structures. The absorption of energy by the groups apparently decreased the localization of energy on carbon C_1 or C_4 on the cellulose molecule which would result in depolymerization and loss in breaking strength of the fibrous cellulose. The radioprotective effects of furan groups for cellulose were similar to those of benzenoid groups. (auth)

41321 LET EFFECTS ON THE CHEMICAL RESISTANCE OF IRRADIATED POLYMERS. Boyett, R. H.; Becker, Klaus (Oak Ridge National Lab., Tenn.). J. Appl. Polym. Sci.; 14: 1654-6 (Jun 1970).

Since the bulk etch rate of cellulose nitrate and polycarbonate foils in KOH is increased after γ radiation exposures in the 10^7 to 10^9 rad range, the LET dependence of this effect was studied on foils of four different polymers that were irradiated under secondary particle equilibrium conditions with different doses of γ radiation from a ^{60}Co source, and with fast fission neutrons. After irradiation they were etched with 28% KOH at elevated temperatures: cellulose nitrate (15 μ) at 40°C; cellulose triacetate (500 μ) at 60°C; polyethylene terephthalate (13 μ) at 60°C; and dioxidiphenylpropane polycarbonate (10 μ) at 60°C. It was obvious that the neutron dose required for a given foil weight reduction was by a large factor less than the γ dose. The factor depended on dose because the neutron radiation damage was a supralinear function of dose. The considerable LET dependence may be explained by preferential etching along recoil particle tracks that are produced by elastic neutron interactions throughout the polymers. (P.C.H.)

41322 MECHANISMS OF RADIATION-COLOURATION IN SOME POLYMER SYSTEMS. Whittaker, B. London; London Univ. (1969). 115p. Thesis.

To explain the phenomenon of radiation-coloration in Red 400 Perspex, it was suggested that the color center could be neutral semiquinone radicals, formed by a reaction of the dye with atomic hydrogen generated in the radiolysis of the polymer. In support of this view, in two of the PMMA systems studied, namely benzophenone/PMMA and benzanthrone/PMMA it was observed that the radioinduced absorption spectra matched the spectra of known neutral radicals. This being so, the theory of color-center formation by interaction of the solute with atomic hydrogen was developed in relation to the other solute/PMMA and solute/polystyrene systems studied. The study of the kinetics of formation and decay of the color centers in irradiated azobenzene/PMMA indicated that both the solute and the polymer host probably compete for the hydrogen atoms released during irradiation. The kinetics also suggest that the transfer of atomic hydrogen from polymer trapping sites to the solute molecules is reversible, and that in the absence of other factors such as the diffusion of air into the irradiated polymer, a state of equilibrium would be attained. Some of the PMMA systems investigated could find applications in radiation dosimetry. (auth) (UK)

41323 MODERATION PROCESSES IN HOT ATOM CHEMISTRY. Baer, Michael; Amiel, Saadia (Soreq Nuclear Research Centre, Yavne, Israel). J. Chem. Phys.; 53: 407-14(1 Jul 1970).

The various moderation processes involved in hot atom chemistry are discussed. Two main types are considered: (i) moderation processes of hot atoms before entering into a chemical combination, (ii) moderation processes of hot molecules formed with various degrees of translational and internal energies. For the first case, it is proved rigorously that under certain conditions the ratio $\alpha_{m_1}/\alpha_{m_2}$ related to two moderators is equal to $(1-\beta_1)/(1-\beta_2)$ where α_{m_i}, i = 1, 2, is the average energy loss per collision and $\beta_1 = [(M_1 - m)/(M_1 + m)]^2$, with m and M_1 the masses of the projectile and two different moderators. For the second case the medium dependence of the survival probability, or alternatively of the decomposition probability, is derived. As an application of this treatment the reaction $CH_4 + {}^{80}Br \rightarrow CH_3{}^{80}Br + H$, studied experimentally in different noble gases, is discussed. (auth)

41324 PREPARATION OF WOOD-PLASTIC COMBINATIONS ON THE BASIS OF UNSATURATED POLYESTER RESINS. I. EFFECT OF STYRENE CONCENTRATION. Pesek, Maroslav; Jarkovsky, Jaroslav; Pultar, Frantisek (Inst. for Research, Production, and Uses of Radioisotopes, Prague). Jad. Energ.; 16: 228-30(Jul 1970).

The wood–plastic materials formed by unsaturated polyester resins possess good mechanical properties and certain ones outdo the wood–plastics containing other types of polymers. Therefore, attention was given to these combinations with unsaturated polyester resins, and at the same time the possibility of increasing the styrene content in the impregnation mixture was investigated. The kinetics of radiation curing and doses of ^{60}Co gamma radiation needed for the preparation of wood–plastic combinations and for the curing of polyester resin themselves were studied. (auth)

41325 YIELDS OF THE LOWEST TRIPLET AND EXCITED SINGLET STATES IN γ RADIOLYSIS OF LIQUID BENZENE. Hentz, Robert R.; Perkey, Lewis M. (Univ. of Notre Dame, Ind.). J. Phys. Chem.; 74: 3047-54(6 Aug 1970). (COO-38-719).

The γ radiolysis of benzene solutions of 3,5-cycloheptadienone (CHDO) was studied for determination of the yield ^1G of lowest excited singlets of benzene and the yield ^3G of lowest triplets of benzene that do not have the lowest excited singlet as a precursor. By study of the photochemistry of CHDO in various solutions, it was shown that (1) singlet excitation yields CO and hexatriene, with $^1\phi(HT) = 0.44$, but no isomer and (2) triplet excitation yields the isomer bicyclo [3.2.0]hept-6-en-3-one, with $^3\phi(ISO) = 0.16$, but no CO or HT. Study of the quenching of benzene fluorescence (excited with 2537-Å light) by CHDO, trans-stilbene, and trans-octene-2 gave the following values for the product $^1\tau \cdot {}^1k$ of lifetime and specific rate of quenching of the lowest excited singlet of benzene: $^1\tau \cdot {}^1k(CHDO) = 4.8 \times 10^2$ M^{-1}, $^1\tau \cdot {}^1k(trans\text{-}stilbene) = 1.29 \times 10^3$ M^{-1}, and $^1\tau \cdot {}^1k(trans\text{-}octene\text{-}2) = 2.5$ M^{-1}. A value of $\chi = 0.58$ was determined for intersystem crossing efficiency of the lowest excited singlet of benzene by comparison of the photosensitized isomerization of trans-octene-2 in benzene with that in acetone. From results of the photoexcitation experiments and measurements of G(HT) and G(ISO) in γ radiolysis of benzene solutions of CHDO (≤0.05 M), values of $^1G = 1.45$ and $^3G = 4.0$ are obtained. Such values, with the photoexcitation results, are found to be in accord with results of a reexamination of radiation-induced isomerization of trans-stilbene (≤0.1 M) in benzene. Assuming a diffusion-controlled $^3k \approx 10^{10}$ M^{-1} sec^{-1} for triplet transfer from benzene to CHDO and trans-stilbene, $^3\tau \approx 7$ nsec

is estimated for the benzene triplet lifetime from ${}^3\tau \cdot {}^3k(CHDO) = 76\ \underline{M}^{-1}$ and ${}^3\tau \cdot {}^3k(trans\text{-}stilbene) = 61\ \underline{M}^{-1}$. (auth)

41326 PHOTOCONDUCTIVITY OF γ-IRRADIATED METHYLTETRAHYDROFURAN GLASS AT 77°K. Baverstock, K. F.; Dyne, P. J. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Can. J. Chem.; 48: 2182-91(15 Jul 1970). (AECL-3613).

γ-Irradiated glasses of methyltetrahydrofuran at 77°K exhibit photoconductivity on illumination with visible light. A variety of kinetic effects are observed as the wavelength of the exciting light is changed from blue to the near infrared. It is suggested that, due to the coulombic field of the positive ions in the glass, some electrons can be released by red light while others can be released only by blue light. A thermally unstable red sensitive center can also be formed in the glass during illumination with blue light. This unstable center could be a dielectron. (auth) (Canada)

41327 OBSERVATION OF POLYMERIZED FILMS INDUCED BY IRRADIATION OF ELECTRON BEAMS. Yoshimura, Nagamitsu; Oikawa, Hisashi (Japan Electron Optics Lab. Co. Ltd., Tokyo). Shinku; 13: 171-7(May 1970). (In Japanese).

A polymerized contamination film, which is formed on a glass surface placed in organic gases under the irradiation of electron beams, was studied. Polymerizing rates were evaluated for vacuum sealing greases and diffusion pump fluids which may be used as lubricants. Organic materials were loaded in a clean chamber and an electron beam from the electron gun was allowed to impinge upon a specimen which is adsorbed on a silver-coated glass target. The thickness of polymerized films was measured by a multi-beam interferometer. All the diffusion pump fluids tested were responsible for polymerized contamination to a considerable extent. Apiezon-M and Apiezon-L greases were only slightly responsible for contamination in spite of prolonged irradiation time. (auth)

41328 EFFECT OF ELECTRON SCAVENGERS ON THE γ-RADIOLYSIS OF GASEOUS H_2S. Huyton, D. W.; Woodward, T. W. (Univ. of Salford, Eng.). Can. J. Chem.; 48: 2300-2(15 Jul 1970).

The effect of the electron scavengers SF_6 and N_2O on the γ-radiolysis of gaseous H_2S was studied. Neither scavenger lowered the radiation yield of H_2, $G(H_2)$. With added N_2O, nitrogen was produced, though not in the amount G_ϵ, the ion pair yield in H_2S. Possible explanations of the findings are discussed. (auth) (Canada)

41329 RADIATION-INDUCED REACTIONS WITH CELLULOSE. VII. EFFECT OF TEMPERATURE AND SUBSTITUTED STYRENES IN THE COPOLYMERIZATION PROCESS. Dilli, S.; Garnett, J. L. (New South Wales Univ., Kensington, Australia). Aust. J. Chem.; 23: 1163-73(Jun 1970).

The temperature dependence of the radiation-induced grafting of styrene to cellulose was studied. The system cellulose-styrene-methanol was examined in the temperature range from 40° to 196°C in order to observe possible ionic contributions to the reaction mechanism. This effect was further investigated using a series of substituted styrenes containing both electron-donating and electron-withdrawing substituents. The 17 monomers used included o-, m-, and p-mono-halogenated styrenes, a number of alkylstyrenes and the p-methoxy derivative. An attempt was made to correlate the grafting results with the Hammett constants for the substituent. The consumption of monomer during grafting of styrene to cellulose was also investigated. (Australia)

41330 γ RADIOLYSIS OF 2-PROPANOL. V. OXIDATION BY CARBON TETRACHLORIDE. Radlowski, Cecelia; Sherman, Warren V. (Chicago State Coll.). J. Phys. Chem.; 74: 3043-7 (6 Aug 1970).

Dilute solutions of carbon tetrachloride in 2-propanol were subjected to ${}^{60}Co$ γ irradiation. Reduction of the solute to chloroform and hydrogen chloride was observed with the concomitant oxidation of the solvent to acetone in accord with the stoichiometry: $CCl_4 + (CH_3)_2CHOH \rightarrow CHCl_3 + HCl + (CH_3)_2CO$. The 100-eV yields were independent of initial carbon tetrachloride concentration in the range 1×10^{-2} to 2×10^{-1} M but showed a first-order dependence on 2-propanol concentration when the system was diluted with 2-methyl-2-propanol. A chain mechanism is indicated by the magnitude of G(products); inhibition by O_2 is consistent with free radical intermediates being involved. The observed dose-rate dependence is in accord with free radical chain carriers undergoing second-order termination. The data are consistent with the chain propagation steps, $\dot{C}Cl_3 + (CH_3)_2CHOH \rightarrow CHCl_3 + (CH_3)_2\dot{C}OH$ (3) and $(CH_3)_2\dot{C}OH + CCl_4 \rightarrow (CH_3)_2CO + HCl + \dot{C}Cl_3$ (4), with $k_3 = 3\ \underline{M}^{-1}\ sec^{-1}$ and $k_3 < k_4$. (auth)

41331 RADIOLYSIS TRANSIENTS IN VISCOUS LIQUIDS. BIPHENYL IN LIQUID PARAFFIN. Fuller, J.; Peteleski, N.; Ruppel, D.; Tomlinson, M. (Whiteshell Nuclear Research Establishment, Pinawa, Manitoba). J. Phys. Chem.; 74: 3066-73 (6 Aug 1970).

Formation and decay of transient species produced in pulse-irradiated solutions of biphenyl in liquid paraffin were studied spectrophotometrically at temperatures from +20 to -20°C. The rates of solute ion recombination and solute triplet quenching are correlated with the viscosity by $k_r \propto \eta^{-n}$ where n = 0.5. This departure from n = 1 for simple liquids is accounted for quantitatively by differences in solute-solvent and solvent-solvent interaction energies. Electron scavengers greatly reduce the yields of biphenyl ions and triplets. Since the same additives have little effect on photolytic triplets, this indicates that over 80% of radiolytic triplets are formed via routes not available in photolysis. A 60% increase of ion yields at -20° is attributed to paired ions whose recombination is retarded sufficiently to permit detection at a viscosity >100 P. (auth)

41332 HOT ATOM CHEMISTRY OF ${}^{32}P$ IN ALKALI CHLORIDES AND SODIUM SILICATES. Ercan, Meral Tayan. Durham, N. H.; Univ. of New Hampshire (1969). 135p.

Thesis.

Valence distribution and photoannealing of ${}^{32}P$ produced by ${}^{35}Cl(n, \alpha)\ {}^{32}P$ reaction were studied in the alkali chlorides: lithium, sodium, and potassium chlorides. Fisher certified reagent grade alkali chlorides were used without further purification, except that they were annealed at 100°C for two hours to drive off water of absorption. Irradiations of 200 mg quantities of alkali chlorides in vacuum-sealed quartz tubes were carried out at a flux of $2 \times 10^{12} n/cm^2/sec$. The irradiation time was 5 minutes. The irradiated samples were kept at room temperature in darkness for at least one week to permit short-lived nuclides to decay. After being exposed to light of 552 nm for a period of time, the samples were then dissolved in solutions containing PO_4^{3-}, PO_3^-, and PO_2^- carriers. Three aliquots were taken from the sample solution: from the first ${}^{32}P$ was determined as PO_4^{3-} ion, in the second aliquot ${}^{32}P$ was determined as PO_3^- and PO_4^{3-} and in the third ${}^{32}P$ was determined as PO_2^-, PO_3^- and PO_4^{3-}. In all cases, the ions to be separated were converted to PO_4^{3-} and precipitated as $NH_4MgPO_4 \cdot 6H_2O$. The activity in each precipitate was counted with a low-background methane-flow counter. The percentage of ${}^{32}P$ activity in each oxidation state was determined as a function of photo-annealing time. Complex curves were obtained, indicating both oxidation and reduction occurring during annealing. A least squares statistical analysis of the results was done using a computer program to find the best fit of the points. There is a marked difference among the three salts, not only in the distribution of ${}^{32}P$ activity among the three oxidation states, but also in the characteristics of the photoannealing curves. The first suggest a cation effect (Li^+, Na^+ and K^+) and the second the effect of different impurities varying both in nature and quantity from one alkali chloride to the other. An attempt was also made to study the hot atom chemistry of ${}^{32}P$ produced by ${}^{30}Si(t,p){}^{32}Si \xrightarrow[700\ y]{\beta} {}^{32}P$ reaction in sodium silicates. Lithium silicide alloy enriched with 90% ${}^6Li$, 70% by weight of silicon was prepared and irradiated at various reactors to obtain ${}^{32}Si$ by the action of tritium atoms produced by ${}^6Li(n,\alpha)T$ reaction. After irradiation the samples were decomposed in closed systems with sodium hydroxide solution; SiO_2 produced this way was further used to prepare Na_2SiO_3 and Na_4SiO_4. The samples were stored at five different temperatures: -196, -78, 0, 20 to 25, and 100°C for at least a month for ${}^{32}P$ to accumulate. It was intended to analyze for ${}^{32}PO_4^{3-}$, ${}^{32}PO_3^-$ and ${}^{32}PO_2^-$ ions, but enough activity could not be obtained to make sensible comparisons. For each ion about 1 to 3 cpm were obtained on a low-background methane-flow proportional counter which has a background of 0.5 to 2.0 cpm. This project was abandoned because of difficulties in obtaining sufficient ${}^{32}P$ radioactivity in the time available. (Diss. Abstr. Int., B)

41333 ISOMERIC EFFECT IN SZILARD-CHALMERS RECOIL OF ${}^{60m}Co$ AND ${}^{60g}Co$ IN SOME Co(III) COMPLEXES BY IRRADIATION AT A TEMPERATURE NOT HIGHER THAN -80°C. Lazzarini, E.; Fantola Lazzarini, A. L. (Centro Studi Nucleari E. Fermi, Milan). Energ. Nucl. (Milan); 17: 444-7(Jul 1970).

The values of primary and secondary isomeric effects in Szilard-Chalmers recoil of ${}^{60m}Co$ and ${}^{60g}Co$ atoms were determined for twelve Co(III) complexes at the following experimental conditions: irradiation temperature not higher than -80°C; irradiation time 5 min; storage temperature -196°C. The results obtained complete and confirm findings that irradiation and storage temperatures ranging from -196°C up to 20 to 30°C have only a small influence on the correlation between the secondary isomeric effect and the splitting Δ of 3d orbitals of Co(III) complexes. (auth)

41334 YIELD OF CARRIER GENERATION IN ORGANIC SOLIDS UNDER ELECTRON BOMBARDMENT. II. Schott, M.

(Ecole Normale Superieure, Paris). Mol. Cryst.: 10: 399-409 (Jul 1970).

The yield of carriers generated in organic solids by electron bombardment, or by x or γ rays, should be independent of the primary electron energy above 5 keV, independent of the field applied to the solid between ~10^3 and a critical field of about 10^4 V/cm at room temperature, and roughly proportional to temperature in this range. Above the critical field, the observed yield should increase with the applied field and be very weakly temperature dependent. The comparison of the yields in different materials is a way of investigating the mechanisms of thermalization of secondary electrons, as the only other material-dependent parameter, the optical dielectric constant, is only slightly variable. The yield of carriers generated by low energy (MeV) protons, deuterons and alpha particles should be proportional to the particle track length, and should vary with temperature and with electric field (normal to the track), approximately as the yield under electron bombardment. (auth) (UK)

41335 γ-RADIOLYSIS OF HYDROCARBONS USING PERFLUOROCYCLOHEXANE AS AN ELECTRON SCAVENGER: DETERMINATION OF THE FREE ION YIELDS. Sagert, N. H.; Reid, J. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem.; 48: 2429-32(1 Aug 1970). (AECL-3621).

The room temperature, liquid phase radiolysis of n-hexane, 3-methylpentane, and 2,2,4-trimethylpentane was examined using perfluorocyclohexane as an electron scavenger. Yields of $C_6F_{11}H$ and $C_6F_{11}CH_3$ were determined for scavenger concentrations below 5×10^{-3} M, and from these results free ion yields of 0.08, 0.17, and 0.37 G units were deduced for n-hexane, 3-methylpentane, and 2,2,4-trimethylpentane, respectively. These results are in good agreement with those obtained by other methods. (auth) (Canada)

41336 INFLUENCE OF IONIZING RADIATION ON CELLULOSE HYDRATE IN ALKALINE MEDIA. Toshchakova, L. F.; Rozenblyum, N. D.; Bubyreva, N. S.; Dolgova, R. V. Zh. Prikl. Khim.; 43: 1419(Jun 1970). (In Russian).

Studies were made on the effects of γ radiation on cellulose hydrate in a strongly alkaline media in the presence of oxygen. The mechanical strength of the irradiated cellulose hydrate in alkaline media was almost lost at 4 to 5 Mrad doses, which are twofold lower than those used during irradiation in a dry-air state. The mean polymerization of the cellulose hydrate also became faster (twofold) than it did during irradiation in dry-air state. Thus, data obtained showed that γ irradiation in alkaline media in the presence of oxygen intensified destruction processes in cellulose hydrate oxidation. Data obtained by chemical analysis are in good agreement with the data of ir spectra. (R.V.J.)

41337 RADIOLYTIC REACTIONS IN AQUEOUS SOLUTION IN THE PRESENCE OF SOLIDS. Haissinsky, M. (Laboratoire Curie, Paris). Radiochem. Radioanal. Lett.; 4: 189-93(31 Jul 1970). (In French).

The catalytic oxidation of U(IV) and of KI by ionizing radiation in solution in the presence of ThO_2 is explained by the formation of thorium peroxide as an intermediate. The catalytic reduction of Ag_2SO_4 by metallic silver in irradiated aerated solution is attributed to the inhibition of the inverse reaction, reoxidation by oxygen of the produced silver atoms. (auth)

41338 SYNTHESIS AND PROPERTIES OF TRANSFERMIUM ELEMENTS (Z > 100). Flerov, G. N.; Druin, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). At. Energy Rev.; 8: 255-326(Jun 1970).

The background and present situation of research on the synthesis and properties of chemical elements with Z ≥ 100 are discussed. The methods used for synthesizing transuranic elements and for separating and identifying nuclear reaction products are described, along with the properties of the individual elements and their classification. The possible existence of a new, relatively stable region of super-heavy nuclei is mentioned, and the prospects of synthesizing them and of finding them in nature are analyzed. 171 references. (auth)

41339 YIELD OF RADIATION-INDUCED IONIZATION IN CONDENSED ORGANIC SYSTEMS. Shida, Tadamasa (Inst. of Physical and Chemical Research, Saitama, Japan). J. Phys. Chem.; 74: 3055-62(6 Aug 1970).

The yield of ionization in γ-irradiated amorphous organic solids at 77°K was determined using alkyl disulfides as charge scavengers. The disulfide anion produced on scavenging electrons was measured by optical absorption spectroscopy for a number of solutions in various solvents, covering the complete range of concentration from pure solvent to pure disulfide. The yield of the anion showed a linear dependence on the electron fraction of disulfide in the solution. Based on the known oscillator strength of the Wurster's ion and the yield of scavengeable electrons in irradiated methyltetrahydrofuran the G values of ionization in pure amyl disulfide as well as in pure solvents were determined to be ~1 to ~3. It is proposed that the observed yields may correspond to the total ionization in the amorphous solids and that the W value may not have relevance to the ionization in solids. (auth)

41340 PARAMAGNETIC SPECIES IN GAMMA-IRRADIATED DURENE CRYSTALS AT ROOM TEMPERATURE. Monge, J. L.; Schott, M. (Ecole Normale Superieure, Paris). Mol. Cryst.: 10: 389-97(Jul 1970).

A study of the EPR spectrum of γ-irradiated durene single crystals showed the presence of at least four radicals, three of which were tentatively assigned to tetramethylcyclopentadienyl, tetramethylcyclohexadienyl, and 2,4,5-trimethylbenzyl. (auth) (UK)

41341 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID STATE POLYMERIZATION. XXVII. POLYMERIZATION OF CHOLESTERYL ACRYLATE AND ITS TWO-COMPONENT SYSTEMS. Hardy, Gyula; Nyitrai, Karoly. Magy. Kem. Foly.; 76: 182-6(Apr 1970). (In Hungarian).

The polymerization kinetics of cholesteryl acrylate in 0.9 mole/l chloroform solution has been investigated. The total activation energy of the radioinduced liquid state polymerization is 4.3 kcal/mole and the process is characterized by a chain transfer reaction to the solvent. In the smectic liquid crystalline state the polymerization kinetic curves are linear below 20°, but above this temperature they become of the accelerated type. In spite of this, the polymerization takes place in the lattice, and the accelerated character appearing above 20° is due to the fact that the polymer produced cannot remain accommodated in the lattice of the monomer at these temperatures, and separates as an amorphous product forming another phase. This conclusion is supported by the fact that the molecular weight of the polymer obtained does not depend on the dose rate or the conversion; further evidence is afforded by the regularities in the behavior of the two-component systems formed with the isomorphous cholesteryl propionate and with p-benzoquinone, of which the latter gives an eutectic with cholesteryl acrylate. (auth)

41342 MOESSBAUER SPECTROSCOPY STUDIES OF THE RADIOLYSIS OF FERRIC COMPOUNDS. Saito, N.; Tominaga, T.; Morimoto, T. (Tokyo Univ.). J. Inorg. Nucl. Chem.; 32: 2811-13(Aug 1970).

A Moessbauer study of valence changes (reduction) of iron in irradiated ferric lactate, citrate, and malate, all of which contain carboxyl groups in their anionic components is described. The samples were irradiated at room temperature in a ^{60}Co irradiation chamber, at a dose rate of about 5×10^5 R/hr. The samples of citrate were subjected to total doses of 2 to 8×10^8 R in sealed glass tubes in the presence of air, while those of the lactate and malate were irradiated to 8×10^8 R in sealed glass tubes containing CO_2. The Moessbauer absorption spectra of the γ-irradiated and unirradiated Fe compounds were obtained at room temperature by means of a mechanical constant velocity drive spectrometer with a ^{57}Co source diffused into Cu foil, and calibrated with sodium nitroprusside dehydrate. The results are described and discussed and the Moessbauer spectra of the γ-irradiated and irradiated ferric salts are shown. As in the previously described case of ferric oxalate, radiolysis of the carboxyl groups in the lactate, malate and citrate was followed by reduction of the Fe(III). Since Moessbauer spectra mainly reflect the changes in the immediate vicinity of ^{57}Fe atoms, however, the analysis of gaseous radiolytic products, as well as the quantitative estimation of the Fe^{2+}/Fe^{3+} ratio, may be necessary for a complete understanding of the kinetics and mechanism of the radiolytic reaction occurring in these systems. (UK)

41343 LOCATION AND DISTRIBUTION OF N-METHYLOL ACRYLAMIDE IN THE RADIATION-INDUCED DELAYED-CURE PROCESS. Broughton, Royall M.; Rollins, Mary L.; Walsh, W. K. (North Carolina State Univ., Raleigh). Text. Res. J.: 40: 672-4(Jul 1970).

A technique was developed for staining a cellulose finishing agent, N-(hydroxymethyl)acrylamide (NMA), with osmium tetroxide. Photomicrographs were produced with contrast to allow observation of NMA within the fiber. Results indicated that NMA, applied to cotton, became located between the elementary fibrils of the fiber and in other structural faults. The absence of distinct stain lines in the γ-irradiated samples indicated that NMA had formed cross links between elementary cellulose fibrils. Results indicated that osmium tetroxide staining is a useful tool in locating unsaturated compounds within cellulose. (J.G.B.)

41344 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID STATE POLYMERIZATION. XXVI. STRUC-

TURAL STUDIES RELATED TO THE POLYMERIZATION OF CHOLESTERYL ACRYLATE. Hardy, Gyula; Cser, Ferenc; Kallo, Antal; Nyitrai, Karoly; Bodor, Geza; Lengyel, Belane. Magy. Kem. Foly.; 76: 176-82(Apr 1970). (In Hungarian).

The phase conditions of cholesteryl acrylate, acetate, and propionate were investigated together with the two-component systems formed by cholesteryl acrylate and the two latter derivatives. The smectic structure of cholesteryl acrylate has been verified by x-ray diffractometry. This structure consists of a double layer of molecules with a thickness of 40 Å, forming planes extended 200 to 250 Å in the other two directions; in these units the acrylate groups are directed towards the inside. The results were also supported by electron microscopic investigations. Depending on the temperature of the polymerizing system, the polymer is isomorphous with the monomer below 0°, but above this temperature it separates from the monomer as globular formations. According to this, the polymerization kinetic curve of the smectic liquid crystalline system is linear or of the accelerated type, depending on the temperature. A light-scattering method has been used to determine the equation defining the specific viscosity vs molecular weight of poly(cholesteryl acrylate). (auth)

41345 UNSTABLE INTERMEDIATES. PART LXXVI. AN ELECTRON SPIN RESONANCE STUDY OF RADIATION DAMAGE IN PERSULPHATE CRYSTALS. INTERCONVERSION OF $S_2O_8^-$ AND SO_5^- RADICALS IN INDUCED BY LIGHT AND HEAT. Symons, M. C. R.; Barnes, S. B. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 11, 2000-2(1970).

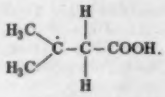
Exposure of various persulphate crystals to γ rays from a ^{60}Co source gave two distinct radicals. That characterised by single lines (or doublets) had $g_1 = 2.0318$, $g_2 = 2.0090$, and $g_3 = 2.0037$. The tensor was very close to that for the peroxyl-radical $O_3SO \cdot O^-$, previously identified in uv-irradiated $K_2S_2O_8$. The doublets were found to be associated with these peroxyl-radicals, trapped in pairs. The second radical had $g_1 = 2.0142$, $g_2 = 2.0047$, and $g_3 = 2.0034$, and a nearly isotropic coupling to ^{33}S with $a_{iso} = \pm 3.5$ G. This species was identified either as SO_4^- or, more probably, as $S_2O_8^-$. An optical absorption in the 590 nm region, found to be associated with this species, was readily bleached by visible light, the radical being converted into $O_3SO \cdot O^-$ in the non-paired form. This was reconverted almost quantitatively into the $S_2O_8^-(SO_4^-)$ species on warming. A possible mechanism for the radiolytic, photolytic, and thermal processes is outlined. (auth) (UK)

41346 EFFECTS OF IONIZING RADIATION ON THE SULFUR DIOXIDE–OXYGEN SYSTEM. V. OXIDATION OF SOLID SULFUR DIOXIDE HEXAHYDRATE AND LIQUID SULFUR DIOXIDE. Schoenherr, S.; Schrader, R.; Mahlitz, P. (Institut fuer Anorganische und Analytische Chemie, Freiberg i. B.). Z. Anorg. Allg. Chem.; 365: 262-8(Apr 1969). (In German).

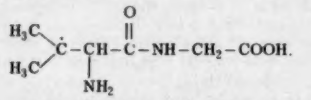
In irradiated solid $SO_2 \cdot 6\ H_2O$ besides SO_3 traces of dithionic acid and polythionic acids are formed. The yields of SO_3 are in SO_2 atmosphere $G(SO_3) = 5.5 \pm 0.4$, in oxygen atmosphere $G(SO_3) = 7.6 \pm 0.6$. Irradiation of liquid oxygen-saturated SO_2 gives in absence of water SO_3 in a yield of $G(SO_3) = 2.79 \pm 0.09$ being G(SO) + G(O) of SO_2 radiolysis. The initial yield of SO_3 is enlarged by addition of water, attaining a value of $G(SO_3) \geq 8$ at static saturation with oxygen, corresponding to a short chain reaction. (auth)

41347 INFLUENCE OF HEAT TREATMENT AND UV-LIGHT ON THE REACTION OF FREE RADICALS PRODUCED IN GLYCYL-DL-VALINE AND DL-VALYL-GLYCINE BY X-IRRADIATION. Schnepel, Gerd Henning (Justus Liebig-Univ., Giessen, Ger.). Biophysik; 6: 315-26(1970). (In German).

It was found that one of the radicals formed by x-irradiation of glycyl-DL-valine is:



Subsequent heating or uv-irradiation of the substance is accompanied by a monotonous decrease of the overall concentration of radicals, whereas the amount of the above mentioned radical reaches a marked maximum before decreasing. It is possible to describe the results of the experiments by assuming that the formation as well as the decomposition of this paramagnetic center occur according to a reaction of first order. The equation $(dy/dt) = ak_1 e^{-k_1 t} - k_2 y$ is valid for the rate of change of the quantity of this radical. The activating energies of these two reactions result from the temperature dependence of the rate constants k_1 and k_2. In order to explain the decay of radicals a mechanism suggested by other authors is quoted in which the generation of a pair of charge carriers is the initial step which determines the rate of reaction. In irradiated DL-valylglycine the following paramagnetic center can be found as a very small fraction of the overall concentration of radicals:



It is formed by separation of a hydrogen atom from the double-methylated carbon atom. (auth)

41348 ELECTRON SPIN RESONANCE OF γ-IRRADIATED TRIGLYCINE SULFATE. II. INTERNAL MOTION OF HYDROGENS AND THE ACTIVATION ENERGY IN GLYCINE(I). Kato, Terumasa; Abe, Ryuji (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 29: 389-93(Aug 1970).

The directions of the CH bonds of $\dot{C}H_2COO^-$ radical in TGS at liquid nitrogen temperature were determined. The activation energy for the exchange of two hydrogens in the radical was also determined to be 0.16 ± 0.03 eV, from the temperature dependence of ESR spectrum. A motional narrowing of proton resonance line in NMR will be expected at about 110°K, if the two hydrogens in glycine(I) would exchange their positions to each other in the unirradiated TGS crystal. (auth)

41349 RADIOCHEMICAL FORMATION OF HYDRAZINE IN AMMONIA–WATER MIXTURES. Proesch, U. (Humboldt Univ., Berlin). Isotopenpraxis; 6: 142-6(Apr 1970). (In German).

Irradiation both of liquid ammonia and ammonia–water mixtures with 1-MeV_{max} x-radiation effects formation of hydrazine. Description is supplied of the dependence of yield from dosage, dose rate, and ammonia–water ratio. (auth)

41350 ELECTRON SPIN RESONANCE OF γ-IRRADIATED CYCLOHEPTATRIENE–SILVER PERCHLORATE COMPLEX. Gee, D. R.; Russell, K. E.; Wan, J. K. S. (Queen's Univ., Kingston, Ont.). J. Chem. Phys.; 53: 847-8(15 Jul 1970).

The stable paramagnetic centers produced during the γ radiolysis of cycloheptatriene silver perchlorate complex were analyzed by ESR. Samples of the complex, which were diamagnetic prior to irradiation, gave ESR spectra when irradiated at room temperature. A typical spectrum consisted of a resolved multiline pattern centered at g = 2.0034 ± 0.0002. The spectral parameters of $C_7H_8^+$ and $C_7H_8^-$ are tabulated. It was concluded that the spectrum arises from some trapped electrons and the $C_7H_8^+$ radical cation. (P.C.H.)

41351 UNSTABLE INTERMEDIATES. PART LXXIV. AN ELECTRON SPIN RESONANCE STUDY OF THE OPTICAL AND RADIATION DAMAGE OF POLY-(2,6-DIMETHYLPHENYLENE OXIDE). Symons, M. C. R.; Yandell, J. K. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 11, 1995-8(1970).

The ESR spectra of uv- and γ-irradiated poly-(2,6-dimethylphenylene oxide) in solution and in the solid state have been interpreted in terms of the formation of a dimethylphenoxyl radical (I) as the only major radical. In benzene at room temperature the magnetic parameters for this radical are $g_{av} = 2.0047$, a_{Me} (I) = 6.2 G, a_{Me} (II) = 5.1 G, and a_H(ring) = 1.1 G. In the solid polymer the same radical has effectively isotropic coupling of 5.7 G to the two nearly equivalent methyl groups and $g_\perp = 2.002_4$, $g_\| = 2.006_3$. At 77°K, after radiolysis in air, the characteristic spectrum of peroxyl radicals ($RO_2^\cdot$) was observed, but irradiation of polymer under vacuum yielded radical (I) together with at least two other radicals. Dipolar interaction between radical pairs has been inferred from the presence of a signal, at g = 4. Radical (I) was present in low concentration even before exposure to radiation, which may mean that it is an intermediate in the synthesis of the polymer. (auth) (UK)

41352 EPR STUDY OF PHENACITE: THE PO_4^{4-} RADICAL. Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Phys.; 53: 857-8(15 Jul 1970).

Phenacite (Be_2SiO_4) crystals were exposed to x and μv radiation and the PO_4^{4-} radical formed. The EPR parameters of this radical are given. (M.C.G.)

41353 DELAYED ABSORBANCE FOLLOWING NANOSECOND PULSE RADIOLYSIS OF WATER. Kenney, Geraldine A.; Walker, David C. (Univ. of British Columbia, Vancouver). J. Chem. Phys.; 53: 1282-3(1 Aug 1970).

Data are presented indicating a temporary increase in absorbance at 632.8 nm in irradiated water, attributable to hydrated electrons, after a very intense, 3-nsec pulse of 0.6-MeV electrons. This increased absorbance could arise from either a delayed

formation of extra e^-_{aq} or a change in the "effective" extinction coefficient. (M.C.G.)

41354 ELECTRON TRAPS IN IRRADIATED WATER–ETHYLENE GLYCOL GLASS AT 4 AND 77°K. Higashimura, Takenobu; Noda, Masato; Warashina, Tetsuo; Yoshida, Hiroshi (Kyoto Univ.). J. Chem. Phys.; 53: 1152-5(1 Aug 1970).

In order to study the mechanism of electron trapping in irradiated glasses of water–ethylene glycol mixture, they were subjected to γ rays and examined by optical absorption and electron spin resonance measurements at 4 and 77°K. Most trapped electrons formed at 4°K give an optical absorption band in infrared region around 1800 nm and a single-line electron spin resonance spectrum with the width of 3 G, while the trapped electrons formed at 77°K give an absorption band in visible region (λ_{max} = 585 nm) and an electron spin resonance spectrum with the width of 15 G. By warming the glass to 77°K after irradiation at 4°K, the trapped electrons transformed to those observed for irradiation at 77°K. Results indicate that the nature of trapped electrons formed at 4°K is very similar to that of trapped electrons in irradiated nonpolar alkane glasses. Even in the polar glass of water–ethylene glycol, the orientation of molecular dipoles is not needed for the formation of electron traps at 4°K, where the molecular movements are highly restricted. By raising the temperature to 77°K, the molecular dipoles in the vicinity of trapped electrons orient favorably to deepen the traps. The yield of trapped electrons, for 100 eV energy absorbed, at 4°K was estimated to be larger than 0.6. However, it is possibly less than 2.0, the yield for the irradiation at 77°K. (auth)

41355 ENDOR STUDY OF X-IRRADIATED SINGLE CRYSTALS OF ICE. Box, Harold C.; Budzinski, Edwin E.; Lilga, Kenneth T.; Freund, Harold G. (Roswell Park Memorial Inst., Buffalo). J. Chem. Phys.; 53: 1059-65(1 Aug 1970).

ENDOR measurements were made on x-irradiated single crystals of hexagonal ice. The ENDOR frequencies yield the hyperfine coupling for the OH radicals produced in irradiated ice. The method is capable of distinguishing between OH radicals produced in three different environments. The principal values of the hyperfine coupling tensors in megacycles per second of the three distinct OH radicals are as follows:

	Axx	Ayy	Azz
(I)	−80.0	−124.4	+9.2
(II)	−81.2	−124.4	+19.4
(III)	−78.2	−126.2	+15.6

Using ESR spectra in conjunction with ENDOR data, the g tensors were also determined with the following results:

	gxx	gyy	gzz
(I)	2.0028	2.0089	2.0597
(II)	2.0031	2.0089	2.0571
(III)	2.0027	2.0088	2.0581

(auth)

41356 NANOSECOND PULSE RADIOLYSIS EFFECT STUDIED SPECTROGRAPHICALLY. Walker, D. C.; Wallace, S. C. (Univ. of British Columbia, Vancouver). Chem. Phys. Lett.; 6: 111-14 (15 Jul 1970).

Absorption spectra were obtained for the benzene excimer and for solvated electrons in water, methanol, and glycerol by a technique utilizing a 3-nanosecond Cherenkov light flash as the internal source for spectrographic detection during pulse radiolysis. (auth)

41357 ELECTRON SPIN RESONANCE OF GAMMA-IRRADIATED SINGLE CRYSTAL OF DIHYDROURACIL. Herak, J. N. (Inst. Rudjer Boskovic, Zagreb). J. Chem. Phys.; 53: 576-8(15 Jul 1970).

Free radicals in gamma-irradiated dihydrouracil have been identified as $-C_{(5)}H_2-\dot{C}_{(6)}H-$. Two sets of resonance lines due to two magnetically distinct molecules were observed. From the direction cosines of the α-proton coupling tensor it has been concluded that the $C_{(6)}$ atom, originally significantly out of the plane defined by the atoms $N_{(1)}$, $C_{(2)}$, $N_{(3)}$, and $C_{(4)}$, comes to that plane after the abstraction of a hydrogen atom from $C_{(6)}$. The nonequivalence of the β-proton couplings proved that the $C_{(5)}$ atom remained out of the plane even in the radical form. Calculated bond energies for the four C–H bonds indicated that the $H_{(6')}$ hydrogen atom should be the most easily removed. That was in agreement with the observations. (auth)

41358 AB INITIO UHF CALCULATIONS. PART 3. NH RADICALS. Claxton, T. A. (Univ. of Leicester, Eng.). Trans. Faraday Soc.; 66: 1540-3(Jul 1970).

A comparison of calculations on the radical ions NH^+ and NH^- supports the assignment that a loosely bound NH^+ radical is observed in γ-irradiated $(NH_4)_2HOP_4$ crystals. Results are also presented for the triplet state radical NH. (auth) (UK)

41359 EFFECT OF RADIATION ON THE REACTIONS OF RECOIL ^{11}C IN PERFLUOROCARBON–OXYGEN SYSTEMS. Finn, Ronald D. (Virginia Polytechnic Inst., Blacksburg); Ache, Hans J.; Wolf, Alfred P. J. Phys. Chem.; 74: 3194-9(20 Aug 1970).

Highly energetic ^{11}C atoms were generated in perfluorocarbon–oxygen mixtures using the 33-MeV proton beam of the Brookhaven National Laboratory 60-in. cyclotron for the $^{12}C(p,pn)^{11}C$ reaction. ^{11}CO and $^{11}CO_2$ comprised 80 to 95% of the total ^{11}C activity produced. The distribution of ^{11}C-labeled products was studied as a function of radiation dose and dose rate. The increasing amount of $^{11}CO_2$ observed at radiation doses of 10^{-4} eV/molecule and higher was found to be formed by radiation-induced oxidation of ^{11}CO, which is formed either directly or via a fluorine-containing intermediate. The kinetics of the oxidation were investigated. As previously observed in the N_2-O_2 system, the oxidation is approximately a linear function of the radiation dose. Substantial amounts of $^{11}CO_2$ observed at very low doses ($\sim 10^{-5}$ eV/molecule), where the conversion to ^{11}CO to $^{11}CO_2$ is negligible, may be the result of the oxidation of ^{11}C-labeled intermediates formed in the reaction of ^{11}C atoms with perfluorocarbons. A comparison of the relative $^{11}CO/^{11}CO_2$ yields in various substrates containing oxygen shows that hydrocarbons exercise a strong inhibitor effect on the radiation-induced oxidation of ^{11}CO to $^{11}CO_2$. A tentative explanation is given in terms of "self-protection" by radiolytically formed reactive species which scavenge the oxidizing reagents in these reaction mixtures. (auth)

41360 PULSE RADIOLYSIS OF PHOSPHATE ANIONS $H_2PO_4^-$, HPO_4^{2-}, PO_4^{3-}, AND $P_2O_7^{4-}$ IN AQUEOUS SOLUTIONS. Black, E. D.; Hayon, E. (Army Natick Labs., Mass.). J. Phys. Chem.; 74: 3199-203(20 Aug 1970).

The pulse radiolysis of aqueous solutions of mono-, di-, and tribasic phosphate, and pyrophosphate anions was examined in the presence and absence of oxygen and nitrous oxide. Broad transient absorption bands were observed in the visible region of the spectrum with maxima at ~500 nm, produced primarily as a result of the reaction of OH radicals with these anions, e.g., $OH + H_2PO_4^- \rightarrow H_2PO_4\cdot + OH^-$. By following the change in the absorption of the transients from the three phosphate anions as a function of pH, in the range 3 to 14, it was possible to demonstrate that these radicals undergo acid-base proton dissociations, to identify the nature of the radicals, and to derive pK values for the radicals

$$H_2PO_4\cdot \underset{+H^+}{\overset{pK\sim 5.9}{\rightleftharpoons}} HPO_4^-\cdot \underset{+H^+}{\overset{pK\sim 10.7}{\rightleftharpoons}} PO_4^{2-}.$$

The pK values of the phosphate radicals were significantly lower than those of the parent anions. The parameters of the radicals were as follows: H_2PO_4. (λ_{max} 500 nm, ϵ ~400 M^{-1} cm^{-1}, 2k ~1.0×10^9 M^{-1} sec^{-1}), HPO_4^-. (λ_{max} 500 nm, ϵ ~800 M^{-1} cm^{-1}, 2k = 4.7×10^8 M^{-1} sec^{-1}), and PO_4^{2-}. (ϵ 4800 M^{-1} cm^{-1} at 500 nm, 2k ~ 1.0×10^9 M^{-1} sec^{-1}). At near-neutral pH values, the HPO_4^-. radicals predominated and entered into subsequent reactions. (auth)

41361 PULSE RADIOLYTIC INVESTIGATION OF THE CARBOXYL RADICAL IN AQUEOUS SOLUTION. Fojtik, A.; Czapski, G.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). J. Phys. Chem.; 74: 3204-8(20 Aug 1970).

Optical absorption and electrical conductivity measurements were performed simultaneously to study the intermediates in the pulse radiolysis of aqueous solutions of carbon monoxide and formic acid. CO^- which was formed by the addition of the hydrated electron to CO absorbs at 2600 Å with ϵ (1200 ± 200) M^{-1} cm^{-1}. It was rapidly protonated. The carboxyl radical was formed in the oxidation of CO by OH. Its pK value is 3.9 ± 0.3, and its molar conductivity 63 ± 4 ohm^{-1} cm^2 mol^{-1}. The same pK and molar conductivity was found for the oxidation product of formic acid. CO_2^- and COOH both reduced nitrobenzene with rate constants of (1.0 ± 0.2) × 10^9 M^{-1} sec^{-1} and (5.6 ± 1) × 10^8 M^{-1} sec^{-1}, respectively. CO_2^- transferred its electron to O_2. (auth)

41362 ACID DISSOCIATION CONSTANT AND DECAY KINETICS OF THE PERHYDROXYL RADICAL. Behar, D. (Hebrew Univ., Jerusalem); Czapski, G.; Rabani, J.; Dorfman, Leon M.; Schwarz, Harold A. J. Phys. Chem.; 74: 3209-13(20 Aug 1970).

The acid dissociation constant of the perhydroxyl radical was found to be 4.88 ± 0.10 in a pulse radiolysis study of oxygen-saturated aqueous solutions. The solutions were buffered with formic acid–sodium formate that also served to transform the hydroxyl radicals into perhydroxyl radicals by reaction with the formate and subsequent reaction with oxygen. This pK value is in

agreement with one earlier value, but in disagreement with others. The discrepancy is shown to be most likely due to the absence of buffer in most earlier work. The second-order kinetics of recombination of perhydroxyl radicals follow the equation, $k = (0.76 \times 10^6 + 8.5 \times 10^7 X)/(1 + X)^2$, where X is the ratio of the dissociation constant to the acid concentration, 0.76×10^6 M^{-1} sec^{-1} is the rate constant for the reaction $HO_2 + HO_2$, and 8.5×10^7 M^{-1} sec^{-1} is for the reaction $HO_2 + O_2^-$. The rate constant for the reaction $O_2^- + O_2^-$ is shown to be less than 100 M^{-1} sec^{-1}. The results suggest that only two forms of the perhydroxyl radical, HO_2 and O_2^-, exist in the pH region 0 to 13. (auth)

41363 FAILURE OF HYDRATED ELECTRONS TO INITIATE NITROGEN FIXATION DURING γ RADIOLYSIS. Shaede, E. A.; Edwards, B. F. P.; Walker, D. C. (Univ. of British Columbia, Vancouver). J. Phys. Chem.; 74: 3217-20(20 Aug 1970).

Although the hydrated electron is one of the most powerful and reactive reducing agents, it is unable to cause reduction fixation of molecular nitrogen. An upper limit of $k_1 < 20$ M^{-1} sec^{-1} was estimated for the rate constant of the reduction reaction. Hydrated electrons were generated by γ radiolysis of an aqueous solution of H_2 and OH^- which also contained N_2 at concentrations up to 0.2 M (400 atm pressure). Significant yields of HN_3 were obtained, but by completely eliminating the gas space above the solution, it was shown that all NH_3 arose through "direct action" of the radiation on dissolved N_2. (auth)

41364 STUDY OF THERMAL DECAY OF TRAPPED ELECTRONS AND OTHER SPECIES IN AN ORGANIC GLASS BY RAPID-SCAN ELECTRON SPIN RESONANCE. Ogasawara, Masaaki; Ohno, Keiichi; Hayashi, Koichiro; Sohma, Junkichi (Hokkaido Univ., Sapporo). J. Phys. Chem.; 74: 3221-4(20 Aug 1970).

The thermal decay of the trapped electrons and other intermediates in γ-irradiated 2-methyltetrahydrofuran glass was studied by means of rapid-scan ESR measurements. The decay curve of the trapped electrons was found to be a superposition of two reactions having different first-order rate constants. These rate constants were determined to be 2.2×10^{-1} sec^{-1} and 4.5×10^{-2} sec^{-1} at 93°K for the fast reaction and the slower one, respectively. The radical decay curve demonstrated intermediate kinetics between first-order and second-order reactions. The fast and slow reactions of the trapped electrons were ascribed to two kinds of positive entities in the spurs. (auth)

41365 MATRIX ISOLATION AND DECAY KINETICS OF CARBON DIOXIDE AND CARBONATE ANION FREE RADICALS. Hisatsune, I. C.; Adl, T.; Beahm, E. C.; Kempf, R. J. (Pennsylvania State Univ., University Park). J. Phys. Chem.; 74: 3225-31(20 Aug 1970).

The carbon dioxide (CO_2^-) and the carbonate (CO_3^-) anion free radicals were generated and trapped at room temperature in pressed potassium halide disks by exposing to γ ray disks containing, respectively, the formate ion and the monomeric bicarbonate ion. Typically, about 10^{-7} mol of CO_2^- and about 10^{-6} mol of CO_3^- were trapped in disks weighing approximately 0.5 g. The concentrations of CO_2^- were sufficient to observe its characteristic infrared band at 1665 cm^{-1} (KBr matrix), but those for CO_3^- were too low to detect its absorption bands in the infrared or the uv-visible region. The ESR spectrum of CO_2^- was broad and showed no temperature dependence when the host matrix was cooled to liquid nitrogen temperature, but a similar cooling of the CO_3^- radical caused a marked broadening of its sharp ESR line. The latter line width followed an Arrhenius type equation with energies, which are believed to be rotational barriers, of 1.024 ± 0.060, 0.527 ± 0.047, and 0.108 ± 0.012 kcal/mol in KCl, KBr, and KI matrices, respectively. In the KCl matrix at liquid nitrogen temperature, the ESR line exhibited an anisotropic splitting with g values of 2.0067, 2.0088, and 2.0162. The CO_2^- radical reacted rapidly with water, giving bicarbonate and formate ions, but under anhydrous condition it decayed by a bimolecular process $2CO_2^- \rightarrow CO + CO_3^{2-}$. The rate constants determined by infrared spectroscopy for the latter reaction in the temperature range 97 to 215° were $10^{9.4 \pm 0.1}$ exp [(−18.9 ± 0.2)/RT] and $10^{6.4 \pm 0.1}$ exp [(−11.9 ± 0.2 kcal)/RT] M^{-1} sec^{-1} for KCl and KBr matrices, respectively. Only in KCl was the oxalate ion observed as a minor reaction product. The CO_3^- radical on the other hand, did not react with water but decayed exclusively by a bimolecular process $2CO_3^- \rightarrow C_2O_6^{2-}$ (or $2CO_2 + O_2^{2-}$). The rate constants obtained by ESR spectroscopy for the temperature range 23 to 118°C were $10^{10.3 \pm 0.4}$ exp [(−14.8 ± 0.8)/RT], $10^{9.4 \pm 0.5}$ exp [(−11.9 ± 0.8)/RT], and $10^{10.0 \pm 0.4}$ exp [(−12.1 ± 1.0 kcal)/RT] M^{-1} sec^{-1} for KCl, KBr, and KI matrices, respectively. (auth)

41366 IONIZATION MEASUREMENTS AND ABSOLUTE RADIATION YIELDS IN THE γ-RADIOLYSIS OF GASEOUS HYDROGEN SULPHIDE. Huyton, D. W.; Woodward, T. W. (Univ. of Salford, Eng.). Trans. Faraday Soc.; 66: 1648-55(Jul 1970).

Ion currents produced in hydrogen sulphide in a cylindrical ion chamber by γ radiolysis were measured. Saturation points on the ion current curves were located by application of general recombination theory. These saturation currents were then used to estimate that the average energy $W(H_2S)$ required to produce an ion pair in hydrogen sulphide is 25.3 ± 0.4 eV. Other values determined were $W(CH_3SH) = 25.1 \pm 0.4$ eV, $W(N_2O) = 32.7 \pm 0.4$ eV and $W(SF_6) = 35.0 \pm 0.4$ eV. Hydrogen and sulphur were produced upon irradiation, with radiation yields (molecules per 100 eV energy absorbed, or G-values) $G(H_2) = 7.0 \pm 0.2$ and $G(S) = 7.0 \pm 0.4$ relative to $W(H_2S) = 25.3$ eV. Possible use of the production of hydrogen from the radiolysis of hydrogen sulphide as a gas dosimeter is discussed. (auth) (UK)

41367 WATER REPELLENCY AND DURABILITY OF THE SILICONE-GRAFTED COTTON FABRICS. Shimizu, Harumichi (Tokyo Metropolitan Isotope Research Center); Shinozaki, Yoshiharu; Meshitsuka, Gisuke; Nishide, Shinko. Sen'i Gakkaishi; 26: 168-73(Apr 1970). (In Japanese).

Silicone-grafted cotton fabrics were prepared by using the simultaneous irradiation technique in air. The water repellency, the durability for dry-cleanings, and abrasions of the grafted samples were tested and compared with silicone-coated cotton fabrics prepared by heating in the presence of catalysts. A spray test rating of 100 was obtained for the grafted samples with over 1% grafting and for the coated samples with over 3% add-on. The grafted samples with 1.5 ~ 5.5% grafting showed a contact angle of about 130° against water drops, while the coated samples with 5.0% add-on showed an angle of about 120°. The durability of water repellency was improved by increasing the irradiation dose. The spray test rating of the grafted samples prepared by the irradiation of about 4 Mrads was over 80 even after dry-cleaning 10 times or 10 abrasion tests, but that of the coated samples containing the same amount of silicone was reduced to 50 after 3 treatments. The durability of water repellency of the grafted samples was improved by the heat treatment at higher temperature and/or by ageing. The results indicated that the irradiation grafting technique is much more superior to the usual coating technique for the water repellency and its durability. From the experimental results, it is suggested that the water repellency is influenced by the shape of silicone deposition on the fibers and that the durability of water repellency depends on the degree of bonding of silicone to the fibers. (auth) (Japan)

41368 APPLICATIONS OF RADIATION-GRAFTED POLYETHYLENE. Guimon, Claude (Compagnie Francaise de Raffinage, Paris). Rev. Gen. Caout. Plast.; 47: 775-8(Jun 1970). (In French).

The modification of high density polyethylene by radiation grafting of acrylic acid is described. The applications of radiation-grafted polyethylene for the preparation of heat-bondable films and self-adhesive powders are discussed. (auth) (France)

41369 SURFACE CENTERS OF γ-IRRADIATED SILICA GELS. INVESTIGATION BY THE EPR METHOD OF EFFECT OF ADSORPTION OF OXYGEN AND NITROGEN OXIDES. Lyubimova, O. I.; Kotov, A. G. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ.; 4: 62-7(Jan-Feb 1970). (In Russian).

The effects of adsorption of oxygen and nitrogen oxides on the EPR spectrum of paramagnetic centers of γ-irradiated silica gel were studied. It was concluded that electron and hole centers formed on irradiation are localized both in the silica gel mass and on the surface. The relative fractions of electron and hole centers on the surface were evaluated from EPR spectra following adsorption of the oxygen or nitrogen oxides. (tr-auth)

41370 RADIOLYSIS OF ACETONE. V. INCLUSION COMPOUND OF ACETONE WITH UREA. Karasev, A. L.; Larin, V. A. (Inst. of Electrochemistry, Moscow). Khim. Vys. Energ.; 4: 56-61(Jan-Feb 1970). (In Russian).

Gas-liquid chromatography was used to study the final products from radiolysis of pure urea at 26 and −196°C and the products from radiolysis of the inclusion compound of acetone with urea. Product yields from the radiolysis of urea decreased linearly with the decrease in the electronic fraction of urea in the inclusion compound. Product yields from the radiolysis of acetone showed more complex relations. The possibility of energy transfer from urea to acetone is shown. The observed high product yields from the radiolysis of acetone in the inclusion compound indicated advantageous utilization of energy of excitation transferred from urea to acetone and facilitation of the charge transfer reaction. (tr-auth)

41371 INVESTIGATION OF THE STRUCTURE OF PARAMAGNETIC CENTERS AND THEIR PHOTOCHEMICAL TRANS-

FORMATIONS IN γ-IRRADIATED MONOCRYSTALS OF CYSTEINE HYDROCHLORIDE. Krivenko, V. G.; Kayushin, L. P.; Pulatova, M. K. (Inst. of Biological Physics, Moscow). Khim. Vys. Energ.; 4: 49-55(Jan-Feb 1970). (In Russian).

Paramagnetic centers of three types emerged on irradiation of monocrystals of cysteine hydrochloride at 77°K. In centers of two types, unpaired electrons localized on sulfur atoms, and in radicals of the third type on carbon atoms. The action of ionizing radiation led to the ionization of cysteine molecules and to the formation of anion radicals. Under the action of light ($340 < \lambda < 450$ nm), there was a break in the S–C bond. It was established that other radicals are formed by breaking away of a hydrogen atom from a sulfur atom and subsequent configurational rearrangements at the expense of thermal movement. The orientation of all the paramagnetic centers in the elementary cell of the monocrystal was determined. (tr-auth)

41372 PHOTOLYSIS OF ALCOHOLS ADSORBED ON γ-IRRADIATED SILICA GEL. Shamonina, N. F.; Kotov, A. G.; Pshezhetskii, S. Ya. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ.; 4: 43-8(Jan-Feb 1970). (In Russian).

EPR studies were made on the photolysis of alcohols adsorbed on γ-irradiated silica gel. It was established that the photolysis of alcohol occurs only with participation of surface paramagnetic centers that formed on irradiation of silica gel. The data are explained by transfer to adsorbed alcohol molecules of the radiation energy absorbed by the silica gel in the process of recombination of stabilized electrons and holes. (tr-auth)

41373 RADIOLYSIS OF THE N_2O_4–HNO_3 SYSTEM IN LIQUID AND SOLID STATES. Dmitriev, L. A.; Kamenetskaya, S. A.; Pshezhetskii, S. Ya. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ.; 4: 68-73(Jan-Feb 1970). (In Russian).

The radiolysis of liquid and solid N_2O_4–HNO_3 by ^{60}Co γ radiation was studied. Oxygen was missing from the products of radiolysis at HNO_3 contents up to 6 mole %. Oxygen was formed in smaller quantities than expected at HNO_3 contents from 67 to 100 mole % on radiolysis of the liquid system, while on radiolysis of the solid system, the relation of the amount of oxygen formed to the composition of the system had a maximum. The amount of NO_3^- radicals formed in relation to the composition of the system passed through a maximum. It was found that formation of oxygen in systems with high HNO_3 content is caused by processes with the participation of NO_3^- radicals. (tr-auth)

41374 RADIOLYTIC OXIDATION OF 2-METHYL TETRAHYDROFURAN. Rama Rao, K. V. S.; Sapre, A. V. (Bhabha Atomic Research Centre, Bombay). Radiat. Eff.; 3: 183-7 (Jun 1970).

The γ-induced oxidation of 2-methyl tetrahydrofuran proceeds with a chain reaction giving an organic hydroperoxide as the major product at low doses. The rate of peroxide formation is given by $[d(ROOH)/dt] = 1.3 \times 10^{-9}\, e^{-6300/RT}\, .I^{1/2}$ moles/sec and the rate constant ratio for the chain propagation to the chain termination is given by $k_1 k_6^{-1/2} = 2.18 \times 10^{-9}\ M^{-1/2} S^{-1/2}$ at room temperature. An ionic chain termination by O_2^- was found to be important only in aqueous solutions but not in pure MTHF or mixtures of cyclohexane + MTHF where the low dielectric constant of the medium seems to inhibit the O_2^- formation in appreciable yield. (auth)

41375 GAMMA RADIOLYSIS OF FERROCENE IN CARBON TETRACHLORIDE. Blackburn, R.; Shorthouse, M. A. (Univ. of Salford, Eng.). Radiat. Eff.; 3: 227-30(Jun 1970).

The gamma radiolysis of solutions of ferrocene in carbon tetrachloride resulted in the disappearance of the solute and in the formation of ferricenium ion and inorganic iron ions. Measured yields were G(-ferrocene) = 2.88, G(ferricenium) = 1.54, and G(inorganic iron) = 1.3. The excellent mass balance with respect to iron indicated the absence of any organo-iron products other than ferricenium ion. The ratio G(ferricenium)/G(inorganic iron) of 1.18 gave support to the recent view that the major product of the radiolysis is the complex ferricenium tetrachloroferrate although, since the ratio is rather greater than unity, it would appear that some simple ferricenium chloride is also produced. These experimental results contrast with an early study of the ferrocene–carbon tetrachloride system in which it was claimed that at least 95 per cent of the ferrocene destroyed could be accounted for as ferricenium chloride. A possible explanation of these contradictory conclusions is advanced, based on the use of different techniques for the isolation of the radiolysis products. (auth)

41376 STUDIES ON RADIATION CHEMISTRY OF HALOPHENOLS IN AQUEOUS SOLUTION. PART 1. RADIOLYSIS PRODUCTS OF p-BROMOPHENOL IN AQUEOUS SOLUTION BY γ-IRRADIATION. Komiya, Takashi; Kawakishi, Shunro; Aoki, Hiroo; Namiki, Mitsuo (Nagoya Univ., Japan). Agr. Biol. Chem. (Tokyo); 34: 349-56(Mar 1970).

In relation to the bactericidal action of γ-irradiated halogenophenol solution, studies were made on the radiolysis of ρ-bromophenol in aqueous solutions under anaerobic conditions. Several phenolic compounds were isolated from the radiolysis products, and three of them were elucidated for their structures. One of them was hydroquinone and the other two were assigned as new asymmetrical dimer, 5-bromo-2, 4′-dihydroxybiphenyl and 2-bromo-5, 4′-dihydroxybiphenyl, which were confirmed by the synthesis of their methyl ethers. (auth) (Japan)

41377 STRUCTURE OF ACTIVE SITES PRODUCED BY GAMMA IRRADIATION OF CELLULOSE ACETATE. Yasukawa, Tamio (Tohoku Univ., Sendai); Matsuzaki, Kei. Tohoku Daigaku Hisuiyoeki Kagaku Kenkyusho Hokoku; 19: 257-64(Dec 1969). (In Japanese).

The ESR spectra of γ-irradiated cellulose acetate and its related compounds were examined, and the structure of active sites produced is discussed. At –196°C, two kinds of radicals were found, both of which showed triplet spectra with different g-values. One was relatively stable and was assigned to $\cdot CH_2COO^-$. The other was quite unstable and was tentatively assigned to the radical with the unpaired electron located on C. (auth) (Japan)

41378 PULSE RADIOLYSIS OF AQUEOUS SOLUTIONS. RATE OF REACTION OF OH WITH OH^-. Buxton, G. V. (Leeds Univ., Eng.). Trans. Faraday Soc.; 66: 1656-60(Jul 1970).

The results of competition studies on the reactions of hydroxyl radicals with carbonate ions and ethanol or methanol at high concentration in nitrous oxide- and oxygen-saturated solutions at pH 11 were consistent with O^- being a product of the reaction of e_{aq}^- with N_2O, and with the equilibrium (1), $OH + OH^- \rightleftharpoons O^- + H_2O$, not being established. On this basis, rate constants for the forward and reverse reactions of this equilibrium were determined. The values obtained are $k_1 = (1.2 \pm 0.3) \times 10^{10}\ M^{-1}\ s^{-1}$ and $k_{-1} = (9.2 \pm 2.0) \times 10^7\ s^{-1}$. (auth) (UK)

41379 E.S.R. STUDY OF THE RADICALS PRODUCED BY IRRADIATION IN SOME SATURATED AND UNSATURATED MONO AND DICARBOXYLIC ACIDS. Leibler, Karoline; Wozniak, Jean; Krauze, Stanislas; Checinski, Kasimire (Warsaw Univ.). J. Chim. Phys.; 67: 743-5(Apr 1970). (In French).

Radicals formed as the result of γ irradiation of a number of saturated and nonsaturated mono- and dicarboxylic acids with double bonds were investigated within the temperature range 77 to 293°K. Comparison of the spectra of these acids and their analysis made it possible to distinguish definite radicals whose formation depends on the type of bond in the molecular chain, the reciprocal position of these bonds, and their distance from the carboxyl group. On the basis of certain analogies, several typical radical forms could be distinguished, and conditions for their production were established. The radical transformations upon heating of the substance are also described. The changes were investigated from the standpoint of the mobility of the radicals. The following acids were studied in polycrystalline form: palmitic, stearic, oleic, erucic, linoleic, sorbic, succinic, maleic, and fumaric. (auth) (France)

41380 ELECTRON BEAM CURING OF COATINGS. Suzuki, Yasuhiro; Ueda, Kazuhiro; Nagai, Akio; Shibayama, Kyoichi (Mitsubishi Electric Corp., Amagasaki, Japan). Mitsubishi Denki Giho; 44: 827-33(Jun 1970). (In Japanese).

The viscoelastic properties of polymer networks prepared by radiation curing, and the conventional thermal cure of unsaturated polyester/monomer systems are discussed. The latest developments in radiation curing of polymer/monomer systems are also covered, including unsaturated polyesters, some modified epoxies, and acrylic polymers. (Japan) (TSS)

41381 CREATION OF A DEFECT GIVING RISE TO A THERMOLUMINESCENCE GLOW PEAK IN UREA BY X-IRRADIATION. Butterfield, A. W.; Ericson, L. G. (Univ. of Adelaide). Mol. Cryst.; 10: 425-8(Jul 1970).

Repeated brief x-irradiation of a sample of urea caused an initially absent thermoluminescence peak to grow in intensity, while the brightness of a second peak decreased in such a manner that the total integrated emission intensity remained constant. It is postulated that this is a consequence of a new trapping site being formed at a previously existing defect, and that this is competing for charge with another trap. (auth) (UK)

Radiochemistry

Refer also to abstract 41332.

41382 GEMINATE RETENTION FROM NUCLEAR ISOMERIC TRANSITION AND RADIATIVE NEUTRON CAPTURE IN CARBON TETRABROMIDE–ETHANOL SOLUTIONS. Gennaro, Gerald P.; Collins, Kenneth E. (State Univ. of New York, Buffalo. Western New York Nuclear Research Center, Buffalo). Contract AT(30-1)-3941. J. Phys. Chem.; 74: 3094-3101(6 Aug 1970). (NYO–3941-3).

Geminate retentions of radiobromine atoms activated by nuclear transformations were measured in CBr_4–C_2H_5OH solutions at low CBr_4 concentrations in the presence of iodine. At 21°C the geminate retentions from the $^{79}Br(n,\gamma)^{80m}Br$ and the $^{80m}Br(I.T.)^{80}Br$ transformations and from the $^{81}Br(n,\gamma)(I.T.)^{82g}Br$ transformation sequence are 0.19%, 5.0%, and 0.07%, respectively. The geminate retention from a singly converted isomeric transition is deduced to be 10%. The bases for these values are discussed in terms of the distances of fragment separation and the charging which accompanies a portion of the nuclear transformation events. Geminate retention for CBr_4 in CH_3OH solution is lower than in C_2H_5OH solution while the geminate retention of CBr_4 in n-C_3H_7OH solution is higher than either. (auth)

Separation Processes

Refer also to abstracts 41180, 41189, 41214, 41242, 41245, 41248, 41249, 41338, 41510, 41511, 41531, 41552, 41553, 41643, 41649, 42067, 42072, 42083, 43318, and 43697.

41383 (BLG–435) CHEMICAL DECLADDING OF NONIRRADIATED, STAINLESS-STEEL CANNED URANIUM DIOXIDE FUEL ELEMENTS. Dumont, G.; Goossens, W. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Jan 1969. 41p. Dep. CFSTI (U. S. Sales Only).

In reprocessing nuclear fuel it is necessary to remove the clad prior to treating the fuel itself adequately. For stainless steel-clad fuel, gaseous mixtures of hydrogen fluoride and oxygen at temperatures above 550°C can be used. Data obtained for non-irradiated AISI 304 L stainless steel-clad uranium dioxide pellets are described. Experiments were performed in a boat reactor and in chemical columns up to 10 cm in diameter for assemblies up to 19 elements 50 cm long. These studies revealed the main factors for scale-up such as the geometry of the bundle, the absence or presence of fluidized alumina, the prefluorination of the correct type of alumina, and the influence of the self-regulative character of the reaction. (auth)

41384 (BNWL–1393) WASTE SOLIDIFICATION DEMONSTRATION PROGRAM: CHARACTERIZATION OF NONRADIOACTIVE SAMPLES OF SOLIDIFIED HIGH-LEVEL WASTE. Thompson, R. J.; Mendel, J. E.; Kleinpeter, J. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT-(45-1)-1830. 86p. Dep. CFSTI.

Waste Solidification Engineering Prototypes are being operated, wherein engineering-scale radioactive demonstrations are being conducted with three alternative solidification systems: phosphate glass, spray solidification, and pot calcination. A major activity associated with the demonstration studies is behavior determination of solidified waste products and evaluation of the safety and economic aspects of this behavior as related to the management of high-level wastes. One of the means being used to evaluate the solidified waste is characterization of nonradioactive laboratory samples of phosphate glass and spray solids. The product characteristics that were measured include leachability, thermal diffusivity, heat capacity, density, drip point, thermal shock, dispersibility, crystallinity, and linear coefficient of thermal expansion. These characteristics were compared with the processing parameters of composition, melt-formation temperature, time at melt-formation temperature, rate-of-cooling to storage temperature, and storage temperature. The process temperature used to prepare the solid waste and the storage temperature of the samples have the greatest effect on the physical, chemical, and thermodynamic properties of the phosphate glass and spray solids. The effect of process and storage temperature is most noteworthy in the degree of crystallinity of phosphate glass and in the physical and thermal properties of both products. High process temperature (1200°C) tends to result in a more vitreous phosphate glass than does lower process temperature (1000°C). Storage temperatures of 600°C for 8 weeks promote crystal growth within phosphate glass samples, while 100°C for 8 weeks has markedly less effect. The more crystalline phosphate glass is tougher, conducts heat better, and is less dispersible by mechanical impact than vitreous glass; it is, however, more water leachable. High process temperature (1100°C) and to a lesser extent long times at process temperature (25 hours) may result in a non-homogeneous spray solid. Lower process temperature (800 to [illegible] ceramic-like material that has a higher thermal conductivity on the average than phosphate glass. The leachability of spray melt is quite similar to crystalline phosphate glass, but is not as good as vitreous phosphate glass. (auth)

41385 (CEA-N–1260) SAFETY–CRITICALITY: RECOMMENDATIONS CONCERNING THE FURNACES FOR FISSILE MATERIAL REPROCESSING. Combettes, Christian; Fruchard, Yves; Gey, Albert; Goube, Pierre; Mercier, Claude; Pajot, Jacques; Trouve, Serge (Commissariat a l'Energie Atomique, Paris (France)). Mar 1970. 53p. (In French). Dep. CFSTI (U. S. Sales Only).

The recommendations discussed here concern the study of the following two main classes of furnaces: those processing fissile material of low density, generally with liberation of water; those processing fissile material without any liberation of water (case of a notable change in density, case where no notable change in density occurs). For the first type of furnaces, the most effective type of criticality control is the geometry. For the second one, a limitation of the mass with a moderator control is prescribed. The various types of furnaces are described. The origin of the hazards endangering the criticality and safety and the way to reduce them at design and operating levels are discussed. (France)

41386 (DOCKET-50201–41) WEST VALLEY REPROCESSING PLANT. Reduction in Strontium and Cesium Discharged to Surface Waters. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 14 Aug 1970. 2p. Dep. CFSTI.

Chemical treatment of liquid wastes prior to release to surface waters is discussed. An ion exchange system will be used to reduce the levels of Cs and Sr. (M.C.G.)

41387 (DOCKET-50332–15) BARNWELL NUCLEAR FUEL PLANT. Preliminary Safety Analysis Report, Amendment 5. (Allied-Gulf Nuclear Services, Florham Park, N. J.). 13 Aug 1970. 102p. Dep. CFSTI.

An amendment to the application for construction and operation of the Barnwell plant is presented. The 1969 financial report of Gulf Oil Corporation is included. The partnership agreement between Allied Chemical Nuclear Products, Inc. and Gulf Energy & Environmental Systems, Inc. is submitted. (M.C.G.)

41388 (DP–1234) IODINE RETENTION STUDIES. Progress Report, July–December 1969. Milham, R. C.; Jones, L. R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr 1970. Contract AT(07-2)-1. 16p. Dep. CFSTI.

The retention of iodine by activated carbon was measured by tests simulating predicted conditions during power surge and loss-of-coolant accidents. The iodine retention efficiency of carbon in the power surge test decreases significantly with on-line service in the confinement system, but remains higher than 99.85% after 3.8 years. Studies in the loss-of-coolant test are incomplete. Partial regeneration of the carbon in both tests increased the iodine retention efficiency. A facility with a 5×10^7 rads/hr ^{60}Co source for determining the effect of intense gamma radiation on methyl iodide adsorption, particulate filter media, and other materials is nearing completion. (auth)

41389 (IAE–1904) EFFECT OF THE CATION OF THE SALTING OUT AGENT ON THE SEPARATION OF TRIVALENT ACTINIDE ELEMENTS. Chudinov, E. G.; Pirozhkov, S. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1969. 20p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The effect of the cation of the salting out agent on the separation of americium, curium, berkelium, californium, cerium, and europium by extraction using trioctylammonium and tetraoctylammonium nitrate solutions with pH ranging from 4.0 to 4.5. It was established that the maximal factors in the separation of the elements studied (relative to curium) occur during the extraction from solutions of ammonium and sodium nitrates. The results obtained are interpreted from the viewpoint of Samoylov's structural theory of salting out. (tr-auth)

41390 (K–1780) EXPERIMENTAL INVESTIGATION OF THE REMOVAL OF KRYPTON AND XENON FROM CONTAMINATED GAS STREAMS BY SELECTIVE ABSORPTION IN FLUOROCARBON SOLVENTS: PHASE I COMPLETION REPORT. Stephenson, M. J.; Merriman, J. R.; Dunthorn, D. I. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 17 Aug 1970. Contract W-7405-eng-26. 71p. Dep. CFSTI.

A development project was initiated to investigate and define a process to remove krypton and xenon from contaminated gas. The separation process is based on the selective absorption of the noble gases in a fluorocarbon solvent such as refrigerant-12 (dichlorodifluoromethane). A pilot plant was designed and built to evaluate overall process feasibility and to collect engineering per-

formance data necessary for the design of plant-scale systems. In the first phase of this project, a total of 34 pilot plant tests, all employing refrigerant-12 as the process solvent, were conducted. Operating conditions and performance data, including correlations of mass transfer parameters, are presented and discussed. In the experiments, column decontamination factors as high as 1000 were measured, and the general performance of the pilot plant demonstrated that a continuous selective absorption process of the type studied has the capability of removing essentially all traces of krypton and xenon from a contaminated gas source. The second phase of the work, in which refrigerant-11 (trichloromonofluoromethane) is being evaluated as a process solvent, is now in progress. (auth)

41391 (NP–10676) THE PURIFICATION OF HELIUM IN HIGH TEMPERATURE REACTORS. Project DRAGON. Antill, J. E.; Flowers, R. H.; Bradley, D.; Hodge, N. (Atomic Energy Research Establishment, Harwell (England). Atomic Energy Establishment, Winfrith (England)). Jul 1961. 41p. (DP-Report-46). Dep. CFSTI.

High temperature gas cooled reactors are being designed to release a proportion of their fission products to the gas coolant. The use of graphite as moderator in these reactors necessitates the control of gaseous impurities to minimize corrosion. Methods of removing both fission products and chemical impurities are reviewed. The purification plant currently being designed for the DRAGON reactor is used to illustrate this review. (auth)

41392 (NP–18304) THE DISTRIBUTION OF URANIUM(IV) AT LOW CONCENTRATIONS BETWEEN UNDILUTED TRIBUTYL PHOSPHATE AND AQUEOUS NITRIC ACID PHASES. Eschrich, H.; Kenis, F.; Schmid, E. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Jan 1969. 38p. (ETR-247). Dep. CFSTI (U. S. Sales Only).

The distribution ratios of uranyl nitrate at low initial aqueous concentrations (0.015 to 5.0 g uranium per litre) for the aqueous nitric acid–undiluted tri-n-butyl phosphate system were determined. The uranium(VI) distribution curve shows a maximum at about 6 M and a valley between 10 M and 12 M equilibrium aqueous nitric acid concentration. The increase of the uranium(VI) distribution ratio in the region 12 to 14.5 M nitric acid was established by batch extractions and confirmed by column experiments. The experimental procedures are described and the results obtained are briefly discussed and compared with the data published by other investigators. (auth)

41393 (NP–18345) BIBLIOGRAPHY OF DESALTING LITERATURE, 1969. Research and Development Progress Report No. 552. (Columbia Software, Inc., Fairfax, Va.). Jul 1970. Contract 14-01-0001-2152. 465p. GPO $3.25.

A categorized bibliography is presented, with 4925 references arranged under the following topics: desalting processes, chemical recovery processes, dynamic phenomena, development status, membranes, chemical properties, water, and energy sources. Author and subject indexes are included. (M.C.G.)

41394 (NP-tr–1915) TREATMENT OF RADIOACTIVE WASTE WATER AT THE KRB GUNDREMMINGEN NUCLEAR POWER PLANT. Schroeder, H. J. Translated by G. H. Wheelhouse from Atomwirt., Atomtech.; 14: 363-8(1969). 19p. Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 24: 7490.

41395 (ORNL-TM-3088) THORIUM FUEL CYCLE DEVELOPMENT PROGRESS REPORT NO. 11, JUNE 1970. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 24p. Dep. CFSTI.

Development work on HTGR fuel recycle is reported under the following headings: head-end reprocessing development, refabrication development, materials irradiation, and ^{233}U reprocessing. (M.C.G.)

41396 (ORNL-TM-3112) THORIUM FUEL CYCLE DEVELOPMENT PROGRESS REPORT NO. 12, JULY 1970. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 14p. Dep. CFSTI.

Development work on HTGR fuel recycle is reported under the following headings: head-end reprocessing development, refabrication development, TURF equipment design and engineering, and materials irradiation. (M.C.G.)

41397 (RFP–1357) REDUCTION OF PLUTONIUM HEXAFLUORIDE TO PLUTONIUM TETRAFLUORIDE BY THERMAL DECOMPOSITION. Wing, Ralph O.; Marshall, Robert S. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 13 Aug 1970. Contract AT(29-1)-1106. 11p. Dep. CFSTI.

The thermal decomposition of plutonium hexafluoride (PuF_6) to plutonium tetrafluoride (PuF_4) on a preheated PuF_4 bed was investigated to determine if the reaction could be applied to a plutonium recovery and purification process. Static bed reactor temperatures ranging from 400 to 450°C produced thermal decomposition efficiencies between 91- and 97-percent per pass with some fusion of the bed occurring in each case. With a fluidized PuF_4 bed, the fusion problem was eliminated and 98-percent decomposition was obtained. (auth)

41398 (SRO–344-5) NPR LOT XIV TEST REPORT. (Nuclear Fuel Services, Inc., West Valley, N. Y.). [nd.] Contract AT(38-1)-344. 79p. Dep. CFSTI.

The data generated during the various tests conducted during NPR Lot XIV indicated that: the rate of dissolution of the unirradiated NPR fuel is significantly slower than the low exposure NPR fuel previously processed at NFS and the Acid Recovery System limits the continuous plant processing of low exposure uranium to 1.2 metric tonnes of uranium per day. The maximum system throughputs for low exposure fuel are: Partition Cycle >1.9 but <2.5 MTU/d; Plutonium Cycle, solvent extraction, >40 Kg/d, concentration, <12 Kg/d, ion exchange purification, <7.5 Kg/d; Solvent Treatment, 1.9 MTU/d; Acid Recovery, 1.2 MTU/d. The NFS pulse columns provide stable performance at high volume velocities and wide ranges of pulser settings. During the processing of Lot XIV, the waste evaporator-acid recovery system achieved decontamination factors of 10 to 20. Significant plant decontamination cannot be achieved by processing unirradiated fuel. Such decontamination must include specialized decontamination chemicals and techniques. (auth)

41399 SELECTIVE SEPARATION OF MOLYBDENUM, TUNGSTEN, AND RHENIUM BY SORPTION PROCESSES. Lee, Jai Y.; Reynolds, Dexter H.; Bhappu, Roshan B. Met. Soc. Conf.; 49: 105-24(1968).

From Symposium on Continuous Processing and Process Control, Philadelphia, Pa. See CONF-661219.

The current investigation concerns the separation of Mo, W, and Re in single and mixed systems using sorption media such as ion-exchange resins and activated carbons. The results reveal that the use of certain weak base resins, like Dowex 3, permits the selective separation of Mo from W and Re by simple pH adjustment; all three being loaded on the resin in the pH range 2 to 3, and being selectively eluted above pH 6 and below pH 9. The separation between W and Re is then attained by selective elution employing $HClO_4$. The strong base resins do not permit selective separation using the above technique. The activated carbons investigated behave more or less like the weak base resins and are found to be somewhat more effective for selective separation of the three components under the same conditions. (auth)

41400 ISOLATION OF THE RADIONUCLIDES ^{7}Be AND ^{10}Be FROM RAINWATER AND SOIL. Moeller, P. (Hahn-Meitner-Institut, Berlin). J. Inorg. Nucl. Chem.; 32: 2473-81(Aug 1970). (In German).

A method is given for isolating Be as $Be(OH)_2$ in a chemically pure form from rainwater and soil. It was found that $Be(OH)_2$ contains only the radionuclides ^{7}Be and ^{10}Be. The high selectivity of the chemical treatment was demonstrated by isolating ^{7}Be and ^{10}Be from soil and ^{10}Be produced by neutron irradiation of Be metal. Means of identification of ^{7}Be and ^{10}Be in the samples are discussed. (auth) (UK)

41401 EXTRACTION OF ZIRCONIUM AND HAFNIUM THIOCYANATE COMPLEXES BY CYCLOHEXANE AND TRIBUTYL PHOSPHATE. Golub, A. M.; Sergun'kin, V. N. (Kiev State Univ.). Zh. Prikl. Khim.; 43: 1203-9(Jun 1970). (In Russian).

Studies were made on the distribution of Zr and Hf between cyclohexane or TBP and aqueous phases in the presence of thiocyanate ions and hydrochloric acid, and extraction of $ZrCl_4$, $HfCl_4$, hafnium thiocyanate, and zirconium thiocyanate cyclohexane and TBP in order to determine the physicochemical basis for extraction and separation of Zr and Hf, and also for determination of the composition of the complexes. (R.V.J.)

41402 SYNERGIC EXTRACTION OF TERNARY COMPLEXES OF EUROPIUM(III). Irving, H. M. N. H.; Sinha, S. P. (Univ. of Leeds, Eng.). Anal. Chim. Acta; 51: 39-45(Jul 1970).

It has been shown that the complex $Eu(HSal)_3$ from europium (III) and salicylic acid (H_2Sal) can be extracted from aqueous solutions into isoamyl alcohol. In contrast, extraction by nonhydroxylic solvents (e.g., benzene, hexane) does not occur over the pH range 2 to 5 unless a formally neutral oxygen donor is present; ternary compounds of the composition $Eu(HSal)_3L_2$ (where L = tributyl phosphate, triphenylphosphine oxide, or triphenylarsine oxide) are then extracted. Synergic extraction of $Eu(HSal)_3$ also occurs in the presence of 4-methylpyridine-N-oxide or methyl isobutyl ketone. (auth)

41403 METHOD FOR SEPARATING MOLYBDENUM FROM TECHNETIUM. Hurst, Elmer C.; Hupf, Homer B. (to United States Atomic Energy Commission). U. S. Patent 3,519,385. 7 Jul 1970. Filed 12 Mar 1968.

A method for separating Mo from Tc from a solid mixture of the two consists of contacting the mixture with an aqueous solution of H_2O_2 at a sufficient peroxide concentration and for a sufficient time to dissolve the Mo and Tc, reducing the volume of the resultant solution until at least a portion of the Mo precipitates and then separating the aqueous phase from the precipitate. (Office Gaz.)

41404 METHOD FOR REMOVING SILICA FROM SILICEOUS MATERIALS. Christensen, Eldon L.; Maraman, William J.; Carmichael, John G. (to United States Atomic Energy Commission). U. S. Patent 3,520,679. 14 Jul 1970. Filed 17 Feb 1969.

A method is described for removing silica from particulate siliceous material containing Pu in which gaseous HF is reacted with the material to volatilize the SiO_2 as SiF_4. The method is applicable to the removal of 28 to 48 wt % of SiO_2 from materials with a water content of 50 to 70 wt % by maintaining the reaction under a partial vacuum for a period in the range of 20 to 30 min by initiating the reaction at room temperature with no additional heat being supplied. Subsequently, the metallic Pu can be removed. (B.L.M.)

41405 OVEN FOR PROCESSING IRRADIATED NUCLEAR FUELS. David, Claude; Junger, Jean-Marie; Montellanico, Pierre; Righino, Elio; Wurm, Joseph-Gerard (to EURATOM). British Patent 1,194,624. 10 Jun 1970. Priority date 19 May 1967, Belgium.

An oven for the pyrometallurgical treatment of irradiated nuclear fuel elements comprises an outer shell, an elongated crucible or refractory material within the shell, and removable covers for the crucible and for the shell to provide access to the crucible. The covers are arranged to seal both the crucible and the shell. The oven is supported on bearings for rotational movement between upright, horizontal, and inverted downwardly sloping positions. The rotational movement of the oven serves to agitate the contents of the crucible after the contents are melted. (B.L.M.)

41406 STUDIES ON COMPLEX FORMATION BY SOLVENT EXTRACTION METHOD. V. ON THE COMPLEX FORMATION OF RUTHENIUM(III) AND NITROSYLRUTHENIUM(III) WITH NITROSONAPHTHOLS. Konecny, C. (Inst. of Nuclear Research, Rez, Czech.). Z. Phys. Chem. (Leipzig); 240: 225-43(1969).

The investigation of the Ru(III) – and RuNO(III) – nitrosonaphthol systems in 0.1 m hydrochloric and nitric acid solutions showed the occurrence of the 1:1 and 1:2 species, of which the latter are considerably extractable. The low tendency of $RuRCl_2$ to be extracted can probably be attributed to the tendency to coordinate water molecules and the extractability of the 1:2 chelates can be understood in the completion of ruthenium coordination requirements with supplementary ligands (i.e., NO_3^- and Cl^- ions) to satisfy a characteristic coordination number of six. It is suggested that the organic species are $RuNOR_2NO_3$ and RuR_2ClHCl. The interaction of the six-coordinated ruthenium, present as nitrosylruthenium(III) ion, with nitrosonaphthols resulting in occurrence of RuR_3 species is conditioned by the replacement of the coordinated NO group in the $RuNO^{3+}$ ion by the third molecule of chelating agent. However, no evidence for a complete conversion of the 1:2 to 1:3 species even at elevated temperature was found, which seems to be due to an extremely high stability of the Ru–NO bond in the $RuNO^{3+}$ ion. For the same reason the formation of the 1:3 species is hardly to be expected when the reactions are carried out at room temperature. (auth)

41407 EXTRACTION OF NIOBIUM(V) FROM HYDROCHLORIC ACID SOLUTIONS BY TRI-n-OCTYLAMINE. Sato, Taichi; Kikuchi, Shoji (Shizuoka Univ., Hamamatsu, Japan. Government Chemical Industrial Research Inst., Tokyo). Z. Anorg. Allg. Chem.; 365: 330-6(Apr 1969).

The partition coefficient of niobium(V) between hydrochloric acid solutions and benzene solutions of trioctylamine (TOA) was investigated under various conditions. A spectrophotometric study was carried out for both the aqueous and organic phase. Further, the effects of organic solvent and of amine structure on the extraction of niobium were examined. (auth)

41408 STUDIES ON COMPLEX FORMATION BY SOLVENT EXTRACTION METHOD. IV. NIOBIUM(V) COMPLEXES OF AMINOPOLYCARBOXYLIC ACIDS. Konecny, C. (Inst. of Nuclear Research, Rez, Czech.). Z. Phys. Chem. (Leipzig); 240: 196-207(1969).

The association constants of the Nb(V) – EDTA, Nb(V) – NTA, and Nb(V) – AspA complexes in hydrochloric acid solutions where EDTA is ethylenediaminetetraacetic acid, NTA is nitrilotriacetic acid, and AspA is aspartic acid and the formation constants of the EDTA and aspartic acid complexes of niobium(V) at 20 ± 2°C in 2.0 m-HNO_3 were determined ($\log \beta_1 = 10.54$ for EDTA, $\log \beta_1 = 4.82$ for AspA). It was shown that the interactions between niobium(V) and ligand molecules result in $Nb(OH)_4H_{n-1}Y$ species. The decrease of niobium distribution ratios in the presence of aspartic acid is smaller than in the presence of EDTA and NTA. This can probably be explained by the fact that Nb(V) is coordinated more strongly by the ligands which form more 5-membered rings (quadridentate NTA ligand and hexadentate EDTA ligand) than by aspartic acid which forms one 5-membered and one 6-membered ring. This conclusion is also supported by other comparisons reported previously, where it was observed that many bidentate and tridentate ligands which are known to form 6-membered rings with other metals are less effective with Nb(V) than chelating agents with pronounced tendency toward formation of 5-membered rings such as Tiron or oxalic acid. (auth)

41409 EFFECT OF DILUENTS ON THE EXTRACTION OF THORIUM NITRATE WITH TRIBUTYL PHOSPHATE. Saleh, F. A. (Egyptian Atomic Energy Establishment, Cairo). Z. Anorg. Allg. Chem.; 371: 106-12(Dec 1969).

Investigations on the extraction of thorium nitrate with TBP diluted with various diluents were made. At lower concentrations of thorium (<150 g ThO_2/l) and lower concentrations of nitric acid (<5 M HNO_3) in the aqueous solution, extraction depends very much on the nature of diluents used. The greatest extraction ability is shown by TBP diluted with commercial kerosene than with toluene, rising sun kerosene, benzene, hexane, xylene, carbon tetrachloride, diethyl ether and diisopropyl ether. At higher concentrations of thorium (>150 g ThO_2/l) and/or higher nitric acid concentrations (>10 M-HNO_3/l) as well as very low nitric acid concentrations (<1 M-HNO_3/l) differences in the distribution coefficient of thorium decrease and almost disappear. Also, at very low and very high concentrations of TBP the dependence of distribution coefficient of thorium on the nature of the diluents is very small. (auth)

41410 THEORY OF ISOTOPE SEPARATION, ESPECIALLY REGARDING A RELATION BETWEEN THE MULTIPLICATION OF ELEMENTARY PROCESS AND THE KINETICS OF COLUMN OPERATION. Shimokawa, J. (Japan Atomic Energy Research, Inst., Tokai). Isotopenpraxis; 6: 121-30(Apr 1970).

Efforts to place separation of isotopes, especially by chromatography or column operation, on a theoretical basis are reviewed. Emphasis is placed on fundamental principles and concepts rather than on details of experimental investigations. Theoretical studies fall into two main lines of approach. The first line of approach is characterized by the application of the ion exchange or extraction theory to isotope separation; historically this approach as a consequence of the fact that the ion exchange chromatography was applied to practically the isotope separation of elements. The second line of approach is represented by the chemical exchange method has hitherto been used in two-phase separation. This approach is applied to interpret the experimental results that were obtained on the uranium isotope separation by the reverse frontal technique and on the lithium isotope separation by the band-elution technique. The relation between the two lines of approach is systematized. (auth)

41411 SEPARATION OF IRON ISOTOPES BY CHROMATOGRAPHY. Knyazev, D. A.; Dobizha, E. V.; Klinskii, G. D. Isotopenpraxis; 6: 130-3(Apr 1970). (In Russian).

Chromatographic separation of the isotopes ^{54}Fe, ^{55}Fe, ^{56}Fe, and ^{58}Fe by means of two chemical exchange systems (citrate and fluoride systems) was examined. Exchange occurred between $Fe(Z_2O)_3^{3+}$ in the cation exchange phase and Fe^{3+}-citrate as well as $Fe(F_6)^{3-}$ in aqueous solution. Separation was realized by the process of band displacement chromatography under stationary conditions (Spedding method). A column of 2.20-m length and 20-mm diameter was used for the experiments. The band length varied between 75 and 90 mm. The first fraction showed an enrichment of ^{54}Fe in the citrate system and of ^{58}Fe in the fluoride system, respectively. The separation coefficient −1 was determined to (112 ± 7) 10^{-6} for the citrate system and (386 ± 17) 10^{-6} for the fluoride system. (auth)

41412 EXTRACTION OF ZIRCONIUM FROM NITRIC ACID SOLUTIONS BY TRI-n-BUTYL PHOSPHATE AND DI-(2-ETHYLHEXYL)-PHOSPHORIC ACID. Sato, Taichi (Shizuoka Univ., Hamamatsu, Japan). Z. Anorg. Allg. Chem.; 367: 303-12(Jul 1969).

The partition of zirconium(IV) between nitric acid solutions and solutions of tri-n-butyl phosphate (TBP) and of bis(2-ethylhexyl) phosphate (DEHPA) in kerosene was investigated at different conditions. The effect of organic solvent in the extraction by DEHPA was examined. A high resolution ^1H–NMR spectral study was

made of the organic phases from the extraction by TBP. The mechanism of the extractions is discussed in the light of the results obtained. (auth)

41413 EXTRACTION OF Np(IV) BY SOME OXYGEN-CONTAINING SOLVENTS. Abdel-Gawad, A. S.; Shehata, M. K.; El-Naggar, H. A. (Atomic Energy Establishment, C Cairo). Z. Anorg. Allg. Chem.; 368: 221-4(Jul 1969).

The extraction of Np(IV) from aqueous nitrate medium with some mono-alcohols, ethers, and ketones has been investigated. Similarities and qualitative features of the extraction process are discussed. (auth)

41414 ENDLAGERUNG RADIOAKTIVER RUECKSTANDE. (Storage of Radioactive Wastes). Albrecht, E.; Koldtiz, H.; Kuehn, K.; Trabandt, H. E.; Hepp, H.; Kluger, W.; Krause, H. Schriftenreihe des Deutschen Atomforums. Heft 16. Bonn, Deutsches Atomforum e.V. 1969). 43p.

Topics covered include: radionuclides, origin of radioactive waste, treatment of radioactive waste, estimation of the future production of radioactive waste in the Federal Republic of Germany, possibilities for final disposal of radioactive waste, and planned methods for storage of radioactive residues in the Federal Republic of Germany. (M.C.G.)

41415 EXTRACTION OF ZIRCONIUM AND HAFNIUM WITH BENZOYLHYDROXYLAMINE. Rudenko, N. P.; Al Samarai, A. M. Zh. Neorg. Khim.; 15: 1343-4(May 1970). (In Russian).

The extraction of Zr and Hf at a concentration of 10^{-6} mole % by chloroform, methyl butyl ketone, and hexanol from HCl solutions in the presence and absence of benzoylhydroxylamine was studied. From weakly acid solutions Zr and Hf are extracted in the form of chelates with any of the three solvents. From solutions with high concentrations of HCl, chloroform extracts metal halide salts and methyl butyl ketone and hexanol extract both the salts and free acids of zirconium and hafnium. (tr-auth)

41416 RECOVERY AND APPLICATION OF THE TRANSURANIUM ELEMENTS ^{237}Np, ^{238}Pu, ^{241}Am, ^{242}Cm, ^{244}Cm, and ^{252}Cf. Baybarz, R. D. (Oak Ridge National Lab., Tenn.). At. Energy Rev.; 8: 327-60(Jun 1970).

A survey of the open literature, covering the period 1964 to 1969, on the established processes for separating the isotopes ^{237}Np, ^{238}Pu, ^{241}Am, ^{242}Cm, ^{244}Cm, and ^{252}Cf is presented. Only those chemical processes that are employed in the production of these isotopes are covered. A summary of nuclear reactor production methods and practical application is included for each isotope. (153 references). (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 41455, 41477, 41478, 41495–41498, 41507, 41509, 41525, 41527–41529, 41531, 41538, 41543–41545, 41653, and 43093.

41417 (BNWL–1342) ESTUARINE VERSION OF THE COLHEAT DIGITAL SIMULATION MODEL. Daniels, D. G.; Sonnichsen, J. C.; Jaske, R. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 53p. Dep. CFSTI.

The COLHEAT simulation model, developed jointly on Division of Production and Division of Reactor Development and Technology funds for the Atomic Energy Commission, was modified to simulate spatial and temporal variations of temperature, chemical, and radionuclide concentration above the salt intrusion in coastal plain estuaries where the river flow is dominant. These modifications are explained, and a case study on the Columbia River estuary described. (auth)

41418 (CEA-R-4014) UNDERGROUND NUCLEAR EXPLOSIONS: EFFECTS ON STRUCTURES IN GRANITE. Derlich, Serge (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). May 1970. 37p. (In French). Dep. CFSTI (U. S. Sales Only).

The results obtained during a study of galleries after an underground nuclear explosion in the granite of the Taourit Tan Afella (Hoggar) are presented. After a brief review on the present state of knowledge concerning the equilibrium and the evolution of cavities, and the laboratory work carried out, a detailed examination is made of the phenomena using measurement results and observations made in the explosion surroundings. Galleries dug in rocks having characteristics similar to that of Sahara granites will be destroyed up to a distance $R = 52\ W^{\frac{1}{3}}$, and damaged up to $R = 110\ W^{\frac{1}{3}}$ (R expressed in meters and W, the explosion energy, in kilotons). (auth) (France)

41419 (COO–689–130) CORRELATION AND CHRONOLOGY OF ORE DEPOSITS AND VOLCANIC ROCKS. Annual Progress Report. Damon, Paul E. (Arizona Univ., Tucson. Lab. of Isotope Geochemistry). Jun 1970. Contract AT(11-1)-689. 192p. Dep. CFSTI.

Analytical techniques for age estimation and geological studies are discussed. $^{87}Sr/^{86}Sr$ ratios in rocks, geochronology of various areas, K–Ar dates, helium dating, and geochemical studies are reported. (M.C.G.)

41420 (CSIRO-Trans–10084) DEPENDENCE OF PHOTONEUTRON MEASUREMENTS ON BERYLLIUM IN ORE DEPOSITS ON THE PHYSICAL PROPERTIES OF THE ORES AND SOME CONDITIONS OF MEASUREMENT. Shishakin, O. V. Translated by B. Bergmanis (Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia), from Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 279-86(1968). 17p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 24: 9513.

41421 (CSIRO-Trans–10085) PROSPECTS OF USING Ac–Be AND Po–B NEUTRON SOURCES IN MINING AND EXPLORATION GEOPHYSICS. Blankov, E. B.; Kaipov, R. L.; Leipunskaya, D. I.; Paklinov, V. A.; Savosin, S. I.; Spiridonov, V. P.; Fedorov, V. V.; Shestakov, L. I.; Shimelevich, Yu. S. Translated by B. Bergmanis (Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia), from Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 197-205(1968). 18p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 24: 9522. (Australia)

41422 (USGS–474–23) HYDRAULIC TESTING OF WELL HTH-23 IN CENTRAL NEVADA. Dinwiddie, George A. (Geological Survey, Denver, Colo.). Jun 1970. 34p. Dep. CFSTI.

An analysis was made of data obtained during hydraulic tests in hydrologic test hole HTH-23, Little Smoky Valley, Nevada. The analysis is focused primarily on determining transmissivity of selected intervals within the zone of interest. Further analysis is concerned with determining variations in hydraulic potential in the vertical section and transmissivity, hydraulic conductivity, storage coefficient, and velocity of ground-water movement in selected intervals of the entire hole. Hole HTH-23 penetrated alluvium, welded tuff, and tuffaceous sediments. The composite water level for the interval from 1,377.6 to 2,285.9 m (4,520 to 7,500 ft) was 138.8 m (455.4 ft) below land-surface datum. In the tested intervals from which the data were adequate for analysis, transmissivity ranged from an estimated 6.2×10^{-4} to 5.8 m^3 pd per m (cubic meters per day per meter); hydraulic conductivity ranged from an estimated 8.4×10^{-6} to 1.5×10^{-1} m^3 pd per m^2 (cubic meters per day per square meter); and velocity ranged from an estimated 2.5×10^{-7} to 4.5×10^{-3} mpd (meters per day). However, velocities of ground-water movement through some intervals might be significantly greater, depending on the thicknesses and effective porosities of the water-contributing fracture systems. (auth)

41423 (USGS–474-77) HYDRAULIC TESTING AND SAMPLING OF HOLE Ue-1, IN CENTRAL NEVADA. Central Nevada-7. Dinwiddie, George A. (Geological Survey, Denver, Colo.). Jun 1970. Contract AT(29-2)-474. 25p. Dep. CFSTI.

Hydraulic testing and sampling of hole Ue-1 began on January 31, 1967, and ended on February 13, 1967. Depth intervals tested and sampled were: zone 1, 1,710 feet to total depth; zone 2, 1,508 to 1,706 feet; zone 3, 1,266 to 1,464 feet; zone 4, 788 to 986 feet; and zone 5, 400 to 598 feet. Injection and recovery tests were run on each depth interval. Relative specific capacities calculated from injection data were much smaller than those calculated from recovery data. More mud and lost circulation material in the hole and in the formation during the injection test account for the different relative specific capacities. Comparative composite hydrostatic heads before and after the injection and recovery tests were 211.5 feet below lsd (land-surface datum) and 218.0 feet below lsd. The difference may be due to differences in the conditions of the measurements. Of the five zones tested, only zone 5 did not have at least partial communication around the bottom packer. (auth)

41424 SOME PULSED NEUTRON LOGGING CONTRIBUTIONS TO IMPROVED FORMATION EVALUATION. Fons, Lloyd. J. Petrol. Technol.; 22: 424-32(Apr 1970).

Pulsed neutron logging, because it can be performed in cased wells, is supplying previously unobtainable information for evaluating reservoirs. When spaced in time, these logs make it possible to deduce the nature of water encroachment and hydrocarbon depletion at any stage in the producing life of a well. (auth)

41425 SIGNIFICANCE OF THORIUM, URANIUM, AND POTASSIUM IN SOME EARLY PRECAMBRIAN GRAYWACKES FROM WYOMING AND MINNESOTA. Rogers, J. J. W. (Rice Univ., Houston, Tex.); Condie, K. C.; Mahan, S. Chem. Geol.; 5: 207-13(Jan 1970).

Thorium, uranium, and potassium concentrations have been measured by gamma spectrometry in graywacke sequences from the Wind River Mountains of Wyoming and the Knife Lake area of Minnesota. Thorium concentrations are compatible with the clay, quartz, and lithic contents of the rocks, but the uranium contents are low, thus yielding Th/U ratios in the neighborhood of 5 or above. Assuming that all post-depositional elemental abundance variations in the graywackes have been caused solely by radioactive decay since the rocks were formed (about 3×10^9 years ago), the initial Th/U ratios would have been in the range of 3 to 4. If the graywackes are random samples of the continental crust at their time of formation, then these data support the data of Fahrig and Eade (1968) to the effect that the continental crust 3×10^9 years ago had a Th/U ratio significantly higher than that of the whole earth. (auth)

41426 MULTIDETECTOR NEUTRON LOGGING TECHNIQUE. Nagel, Walter A. (to Schlumberger Technology Corp.). U. S. Patent 3,521,062. 21 Jul 1970. Filed 28 Aug 1967.

One embodiment of the invention provides a sidewall borehole tool for porosity logging that comprises short-spaced and long-spaced neutron detectors. The detectors straddle a chemical neutron source that is mounted eccentrically within a fast-neutron shield of copper in order to abut the side of the borehole. A neutron moderator, moreover, is interposed between the source and the long-spaced neutron detector in order to improve formation porosity resolution. (auth)

41427 COMBINATION NEUTRON AND GAMMA RAY LOGGING TECHNIQUE. Locke, Stanley (to Schlumberger Technology Corp.). U. S. Patent 3,521,065. 21 Jul 1970. Filed 5 Sep 1967.

An illustrative embodiment of the invention measures the matrix composition and porosity of a formation traversed by a cased borehole. The thickness of the casing cement also is measured in the embodiment shown. These measurements are acquired through a logging sonde that combines a gamma-gamma "density"

tool with a two detector neutron "porosity" tool. For each density tool response in a specific mineral composition, the ratio of the neutron counts registered by the two detectors, as contrasted with the neutron counts observed by either of the neutron detectors taken alone, indicates the cement thickness and the formation mineral composition. The mineral composition information and the count ratio then are combined to provide a more accurate formation porosity measurement. (auth)

41428 DETERMINATION OF SOIL DENSITY AND WATER CONTENT BY FAST NEUTRONS AND GAMMA RAYS. Corey, J. C.; Boulogne, A. R.; Horton, J. H. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Water Resour. Res.; 6: 223-9(Feb 1970).

Sequential measurements of gamma and fast neutron attenuation were used for nondestructive determination of both soil density and water content of soil samples. Soils containing known amounts of water were packed into 22.5-cm diameter cylinders to a depth of ~9 cm. Measurements were made of attenuation of fast neutrons from a 3-μg ^{252}Cf source and attenuation of gamma rays in a collimated beam from a ^{137}Cs source. The attenuation was used to calculate the soil density and water content of these samples. The mean difference between the calculated and known water contents was 0.006 g/cm^3 with a standard deviation of 0.010 g/cm^3; the mean difference for soil density was 0.010 g/cm^3 with a standard deviation of 0.017 g/cm^3. Calculations based only on counting statistics show that an attenuation method using a combination of gamma and fast neutrons is better than a method using two gamma energies. (auth)

41429 FISSION TRACK DATING OF ZIRCON IN THE QUATERNARY PERIOD. Yabuki, Hideo: Shima, Makoto (Inst. of Physical and Chemical Research, Yamato, Japan). Rikagaku Kenkyusho Hokoku; 46: No. 3, 59-62(May 1970). (In Japanese).

The fission track method was applied for age dating and measurement of uranium concentration of zircon in Quaternary pumic layers. The Tertiary and Quarternary ages have been considered as difficult to apply the ordinary radioactive dating method. The age dating in these periods can be satisfactorily done by the fission track dating method by selecting zircon containing uranium above about 100 ppM. It is estimated that the three pumic layers in the Shinshu formation (ancient upper loam layer) were accumulated about 60, 45, and 30×10^4 years ago, assuming that the zircon had been cooled and crystallized at the same time as the eruption of volcanos. (auth) (Japan)

41430 DETECTION OF CHEMICAL BINDING OF HYDROGEN. Mills, William R. Jr. (to Mobil Oil Corp.). U. S. Patent 3,497,692. 24 Feb 1970. Filed 9 Mar 1965.

A method for the detection of chemical binding of hydrogen is based on the difference in the neutron moderation properties of the hydrogen atoms when the atoms are in different molecular configurations with other atoms. An unknown sample is irradiated with a short pulse of high energy neutrons and two different energy neutron levels in the energy range of from 0.1 to 1 eV are absorbed from the neutrons issuing from the sample. Signals representative of the number of absorbed neutrons in the selected energy range are generated as function of time, and are recorded to indicate the relative proportions of oil and water in the unknown sample. (auth)

41431 RADIOACTIVE BOREHOLE LOGGING METHOD AND APPARATUS WHEREBY ELEMENTS OF INTEREST ARE DETERMINED BY GENERATING GAMMA RAYS HAVING A PREDETERMINED CRITICAL ENERGY SUCH THAT THEY ARE RESONANTLY SCATTERED BY SAID ELEMENTS. Johnson, Walter H. Jr.; Pritchett, William C. (to Atlantic Richfield Co.). U. S. Patent 3,515,871. 2 Jun 1970. Filed 21 Dec 1966.

A radioactive logging method and apparatus for quantitatively determining an element of interest in subsurface formations transversed by a borehole are described. Earth formations are bombarded with γ rays having a predetermined critical energy such that they are capable of being resonantly scattered by the element of interest. These γ rays are produced by generating a flux of low energy neutrons, moderating the neutrons to thermal energies, and bombarding special neutron capture material. (Offic. Gaz.)

Meteorology

Refer also to abstracts 41227 and 41242.

41432 (JAERI-1189) GRAPHIC AID IN THE ASSESSMENT OF GAMMA-EXPOSURE DUE TO A RADIOACTIVE CLOUD RELEASED FROM A POINT SOURCE. Imai, Kazuhiko; Iijima, Toshinori; Kakuta, Michio (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Jul 1970. 43p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

Distributions of gamma-exposure due to a radioactive cloud released from a nuclear plant under the normal operation or by accidents are given based on a method which uses an electronic computer. An assumption is made that the distribution of nuclide concentration in the cloud is of the generalized Gaussian type, of which the standard deviations, i.e., the so-called cloud-size parameters, are formulated on the basis of F. Pasquill's graphic data. In addition, empirical formulae derived from the results reported by H. Goldstein et al., are applied for the dose-buildup factor. Information is included on: upwind, downwind, and cross-wind axial exposure distributions under various atmospheric stabilities, taking the release-height as a parameter; isopleths of exposure; relation between the maximum exposure and the maximum point, taking the release-height and the stability as parameters; and the dependence of exposure on the energy of primary photons. (auth) (Japan)

41433 (SWRHL-100-r) ENVIRONMENTAL SURVEILLANCE FOR PROJECT GASBUGGY PRODUCTION TEST PHASE. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Jun 1970. 39p. (PNE-G-63). Dep. CFSTI.

Production testing of the Gasbuggy Emplacement Re-entry well took place from November 4, 1968, to November 14, 1969. The Southwestern Radiological Health Laboratory of the Bureau of Radiological Health (BRH) conducted a program of radiological monitoring and environmental sampling to document levels of airborne and deposited radioactivity released to the off-site area during this period. Tritium was chosen as the nuclide of prime interest because of its biological significance relative to other isotopes expected, retention in the environment, and relative ease of collection and analysis. Samples were also analyzed for any other isotopes they might contain. Collection of environmental samples (atmospheric moisture, snow, vegetation, and soil) were made every one or two months. Airborne cryogenic samples were collected during September and October 1969. Tritium, carbon-14, and krypton-85 were detected. The highest levels of tritium activity were found in the November 1968 samples. Activity levels dropped to background by July 1969, then rose slightly in September and October. Maximum carbon-14 levels were three times normal background. Low levels of krypton-85 were detected in aerial cryogenic samples in October 1969. None of the environmental surveillance networks operated by the BRH showed any evidence of activity beyond the 10-mile Gasbuggy surveillance area. It was concluded from the results of this surveillance that production testing of the Gasbuggy re-entry well did not create radioactivity levels in the environment which approached any appreciable fraction of the radiation protection guides. (auth)

41434 (UCRL-72603) PRECIPITATION SCAVENGING IN A LARGE-CLOUD DIFFUSION CODE. Peterson, K. R.; Crawford, T. V. (California Univ., Livermore. Lawrence Radiation Lab.). 28 Jul 1970. 16p. (CONF-700601-1). Dep. CFSTI.

From Precipitation Scavenging Meeting, Richland, Wash.

A large-cloud diffusion code, developed at the Lawrence Radiation Laboratory several years ago, incorporates a precipitation scavenging option. Following a description of the code, a comparison of predicted and diagnostic calculations with observations of cloud center concentrations and surface deposition for the nuclear cratering experiment Cabriolet shows reasonable agreement. (auth)

41435 INDUCED RADIOACTIVITY OF GROUND-LEVEL AIR IN PRAGUE-BULOVKA FROM OCTOBER 1968 TO DECEMBER 1969. Behounek, Frantisek (Technical Univ., Prague); Matouskova, Jirina. Jad. Energ.; 16: 79-81(1970).

The course of induced airborne radioactivity of ground-level air measured at the Prague-Bulovka station from October 1968 to December 1969 presented significant summer maximum in August 1969. On the basis of the presence of short-lived nuclides, detected by gamma spectrometry, the correlation of this maximum with the 8th Chinese nuclear test of December 27, 1968 is discussed. The role played by the presence of old fission debris from nuclear tests in the troposphere for current monitoring of environmental contamination of nuclear installations is pointed out. (auth)

41436 DATA, SECTION III, AIR AND DEPOSITION. Radiol. Health Data Rep.; 11: 199-206(Apr 1970).

Data are presented on atmospheric radioactivity collected by the Radiation Alert Network from 73 locations distributed throughout the United States. A table is presented to show gross β radioactivity in surface air and precipitation for December 1969. Data collected from 24 airport stations in Canada on air and precipitation monitoring during December 1969, are reported and a table showing gross β activity is presented. Data reported by the Mexi-

can Air Monitoring program during September and October 1969, are presented. The maximum, minimum, and average β activities in surface air are tabulated. A summary of gross β activity in surface air sampled at 12 locations in Central and South America is presented. (H.L.W.)

41437 VARIATIONS IN CONCENTRATION OF ^{14}C IN THE ATMOSPHERE FROM 1957 TO 1968 (DENDROLOGICAL DATA). Kolesnikov, N. V.; Gorshkova, I. A.; Biryulin, Yu. F. (Inst. of Oceanology, Moscow). Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana; 6: 647-9(Jun 1970). (In Russian).

Variations in radiocarbon content in pine tree trunks were studied in order to find the relationship between the ^{14}C increase of in the yearly rings and the sudden increase of its concentration in the stratosphere. The hypothesis suggested by B. P. Konstantinov et al. (Dokl. Akad. Nauk, 165: 1(1965)) on the correlation between the content of cosmogenic ^{14}C isotope in the yearly tree rings and the burst of supernova stars and other astrophysical phenomena was analyzed. (R.V.J.)

41438 ATMOSPHERIC ^{85}Kr MEASUREMENTS BETWEEN 1966 AND 1968 IN DEBRECEN (HUNGARY). Csongor, E. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung.; 28: 109-14(1970).

Results of the measurements relating to the ^{85}Kr content of the atmosphere between 1966 and 1968 are discussed. The activity due to ^{85}Kr increased from $11.5 \cdot 10^{-12}$ Ci/m^3 air to $13.5 \cdot 10^{-12}$ Ci/m^3 air. The used fissionable material is estimated to be equivalent to about 141 t thermal fissioned ^{235}U at least. (auth)

41439 LOCATION AND IDENTIFICATION OF A RADIOACTIVE CLOUD BY A VERY SIMPLE RADIOMETRIC METHOD. Petrov, Yu. N. At. Energ. (USSR); 28: 431-2(1970). (In Russian).

Graphic analysis of the activity of fallout may be used for the qualitative evaluation of local and global contamination of the atmosphere. The method is based on the fact that the decay rate of the radioactive isotope mixture due to atmospheric tests declines with the time since the explosion. The radioactive cloud circles the Earth and is gradually dispersed in vertical and horizontal directions. The fallout contains the long-lived aerosols; its study permits the location of each cloud and the determination of the locally-originated contamination. Results of such measurements in the Northwestern European portion of the Soviet Union are presented graphically. The measurements were based on radioactive aerosol and fallout samples collected during periods of one day, one week and one month. The results revealed that up to January 1968 the atmospheric radioactivity was small and was due to long-lived isotopes from earlier nuclear tests. The radioactivity then increased and stayed at the higher level until autumn when it decreased to nearly the original value. It was concluded that the fallout was due to a single radioactive cloud. The method may shorten the radiochemical and spectrometric analysis required to check the radioactivity of the atmosphere near reactors or other potential sources of activity. (TTT)

41440 NEW METHODS OF MEASURING THORON (^{220}Rn) EXHALATION. Styra, B. I.; Nedveckaite, T. N.; Senko, E. E. J. Geophys. Res.; 75: 3635-8(20 Jun 1970).

Two methods of measuring ^{220}Rn exhalation, by disintegration chamber and by nuclear emulsion, are described. The data on the ^{220}Rn exhalation under various weather conditions and states of ground surface are summarized. The average values range from zero, when the snow surface is covered by ice, to 33×10^{-16} curie/cm^2 sec for dry ground in summer. (auth)

41441 MEAN RESIDENCE TIME OF RADIOACTIVE AEROSOLS IN THE UPPER LAYERS OF THE ATMOSPHERE BASED ON FALLOUT OF HIGH-ALTITUDE TRACERS. Leipunskii, O. I.; Konstantinov, J. E.; Fedorov, G. A.; Scotnikova, O. G. J. Geophys. Res.; 75: 3569-74(20 Jun 1970).

The concentrations of ^{109}Cd in fallout and in surface air at observation points in the Soviet Union during 1964 to 1967 are summarized. Analysis of these data and their comparison with results from experiments on ^{107}Rh suggest that the mean residence time of finely divided aerosols in the atmosphere above 21 km from sources above 100 km is 14 years. Analysis of the ^{238}Pu fallout data indicates that the mean residence time of aerosols injected at about 40 to 60 km altitude is significantly lower, possibly about 4 years. (auth)

41442 RADIOACTIVE AEROSOL DISTRIBUTION IN THE MIDDLE AND UPPER TROPOSPHERE OVER THE USSR IN 1963-1968. Nazarov, L. E.; Kuzenkov, A. F.; Malakhov, S. G.; Volokitina, L. A.; Gaziev, Ya. I.; Vasil'ev, A. S. (Inst. of Experimental Meteorology, Obninsk, USSR). J. Geophys. Res.; 75: 3575-88 (20 Jun 1970).

The distribution of radon daughters and concentration of aerosol fission products in the troposphere was measured over the USSR during several periods from 1963 to 1968. An intensive fission product transport from the stratosphere to the troposphere occurs on the cyclonic side of the jet stream. As a rule, the inclusion of these products in the surface air is observed on the anticyclonic side of the jet stream. The simplest theoretical scheme is given to describe the vertical distribution of radon and fission product concentrations in the troposphere; the theory takes into account the vertical turbulent exchange coefficient and vertical motion. The directions of vertical motion, estimated from the vertical distribution of both radon and fission products in the troposphere, agree very closely with meteorological data. (auth)

41443 NUMERICAL MODEL OF THE GLOBAL TRANSPORT OF RADIOACTIVE TRACERS FROM THE INSTANTANEOUS SOURCES IN THE LOWER STRATOSPHERE. Karol, I. L. (Inst. of Experimental Meteorology, Obninsk, USSR). J. Geophys. Res.; 75: 3589-2603(20 Jun 1970).

The temporal change of the zonally averaged monthly mean aerosol concentration in the atmospheric layer up to 25 km is calculated for the instantaneous sources in the lower stratosphere by means of numerical calculation of boundary problems for the two-dimensional macroturbulent diffusion equation; the mean meridional circulation is taken into account. The coefficients of these problems are determined partly from climatic temperature and wind data and partly from comparison of calculations with published data on the global content of some radioactive isotopes produced in nuclear explosions. Results of calculations demonstrate the essential contribution that meridional circulation makes to the seasonal changes of and meridional distributions of zonally averaged isotope fallout π and surface air concentration c_s and the contribution of this circulation to isotope transport across the equator and through the tropopause. The moment of injection has only a slight influence on the seasonal change of π and c_s in the second calendar year of isotope spreading. Meridional distributions of π and c_s are almost independent of the source latitude by 6 months after injection in the hemisphere of injection and by 12 to 15 months in the other hemisphere. (auth)

41444 ^{90}Sr FALLOUT DISTRIBUTION AT MIDDLE LATITUDES OF THE NORTHERN AND SOUTHERN HEMISPHERES AND ITS RELATION TO PRECIPITATION. Malakhov, S. G.; Pudovkina, I. B. (Inst. of Experimental Meteorology, Obninsk, USSR). J. Geophys. Res.; 75: 3623-8(20 Jun 1970).

The dependence of ^{90}Sr deposition on precipitation within each 10° latitude belt is investigated. No satisfactory linear correlation is found for undifferentiated measurements obtained under different climatic conditions. Regions in which the data deviate systematically from the general trend of results in each latitude belt are singled out. A satisfactory linear correlation for most of the data has been obtained for four seasons of the year between 50 and 60°N and for the first and second quarters between 30 and 40°N and 40 and 50°N. In the latter cases, the third quarter is characterized by the largest deviations of the results from a linear dependence. The regression equations for the dependence of ^{90}Sr deposition on precipitation in each latitude belt are given. (auth)

41445 MODEL FOR CAPTURE OF RADIOACTIVITY BY PRECIPITATION. Avramenko, A. S.; Makhon'ko, K. P. (Inst. of Experimental Meteorology, Obninsk, USSR). J. Geophys. Res.; 75: 3613-22(20 Jun 1970).

A rough scheme for radioactive dust particle capture by rain droplets is presented. Processes taking place both within the cloud with regular updrafts and in the layer of the atmosphere below the cloud that lead to a definite distribution of specific radioactivity with droplet size are considered. Comparison of experimental data on the fission-product concentration in raindrops of different sizes with theoretical calculations allowed determination of the coefficient of rainout for removal of radioactive particles by cloud drops $\sigma_0 \sim 10^{-3}$ sec^{-1}, corresponding to an inverse proportionality between concentration and cloud drop radius. The functional dependence obtained theoretically is in good agreement with the experimental data. The influence of the specific radioactivity distribution versus droplet size on the variation of the specific radioactivity during a short-range shower is considered. (auth)

41446 RADON EXHALATION FROM VAST AREAS ACCORDING TO VERTICAL DISTRIBUTION OF ITS SHORT-LIVED DECAY PRODUCTS. Kirichenko, L. V. (Hydrometeorological Service, Moscow). J. Geophys. Res.; 75: 3639-49(20 Jun 1970).

The use of natural radioactivity in the investigation of mixing and transport processes in the atmosphere is impossible without allowing for radon influx from vast surfaces of the earth. An estimate of the effective radon flux from areas with nonuniform ema-

nation is considered. The technique consists of calculating the total amount of natural radioactive products through the entire atmosphere per unit of ground surface. A vertical profile of the α-active short-lived products of radon has been determined by sounding the atmosphere with equipment installed in aircraft. The possibilities of the technique are analyzed. Characteristics of emanation of a number of regions in the Soviet Union are given. (auth)

41447 COSMOGENIC ^{22}Na, ^{7}Be, ^{32}P, AND ^{33}P IN ATMOSPHERIC DYNAMICS RESEARCH. Luyanas, V. Yu.; Yasyulyonis, R. Yu.; Shopauskiene, D. A.; Styra, B. I. J. Geophys. Res.; 75: 3665-7(20 Jun 1970).

Concentrations of ^{22}Na, ^{7}Be, ^{32}P, and ^{33}P were measured in ground-level air during the period 1965 to 1969. The spring maximum of radioisotope fallout is clearly marked. At times the $^{22}Na/^{7}Be$ ratio increased to values characteristic of stratospheric air. (auth)

41448 INVESTIGATION OF TURBULENT EXCHANGE AND WASH-OUT BY MEASUREMENT OF NATURAL RADIOACTIVITY IN SURFACE AIR. Bakulin, V. N.; Senko, E. E.; Starikov, B. G.; Trufakin, V. A. (State Teacher Inst., Kirov, USSR). J. Geophys. Res.; 75: 3669-74(20 Jun 1970).

Based on comparison of methods of measuring the degree of disequilibrium between the short-lived decay products of radon, an improved and simplified method is proposed for general use. In accordance with theoretical considerations, the existence of a linear dependence between RaA/RaB and RaB/RaC concentration ratios in the atmosphere is established, permitting determination of the atmospheric concentrations of Rn, RaA, RaB, and RaC from two points on the radioactivity decay curve for aerosol samples collected on a filter. As a rule, two maximums in the diurnal variation of disequilibrium between radon and its daughter products have been observed. From the differences in this variation at altitudes of 1, 11, and 20 meters, an attempt is made to explain the mechanism of convective and dynamic components of turbulent exchange near the ground. From the diurnal variations of radon and thoron concentrations at 1 and 5 meters and their short-lived decay products at 1, 11, and 20 meters above the ground, the diurnal change in the turbulent diffusion coefficient in the surface layer is computed and compared with that from meteorological parameters. The velocity of washout of the troposphere is estimated from Rn/RaD concentration ratio variations averaged for 1-day intervals. (auth)

41449 SOME PECULIARITIES OF FISSION PRODUCT CONCENTRATION DISTRIBUTIONS OVER OCEANS IN THE TROPICAL ZONE AND THEIR CONNECTION WITH ATMOSPHERIC PROCESSES. Dmitrieva, G. V.; Krasnopevtsev, Yu. V.; Malakhov, S. G. (Hydrometeorological Service, Moscow). J. Geophys. Res.; 75: 3675-85(20 Jun 1970).

New data on the latitude distribution of radioactive fission products over oceans in regions of the tropical zone are given for the period 1967 to 1968. The data show a considerable heterogeneity of radioactive fission products in air in the tropical zone over the Indian Ocean and in the western Pacific Ocean. This heterogeneity is explained by intrusion into the tropical zone of parcels of more radioactive air from subtropical temperate latitudes of the winter hemisphere behind quasi-meridional cold fronts. The radioactive air entered the equatorial region and, under certain synoptic conditions, moved across the equator into the air circulation of the opposite hemisphere. Air transfer from the southern to the northern hemisphere is presumably assisted by typhoons that have been transformed into large-scale cyclones over the Pacific Ocean. (auth)

41450 STUDY OF PROPAGATION OF ATMOSPHERIC POLLUTANTS WITH THE AID OF TRITIUM. Kiefer, H.; Koenig, L. A.; Winter, M. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik; 12: 212-18(May-Jun 1970). (In German and English).

Experiments with tritiated water vapor carried out at the Karlsruhe Nuclear Research Center aimed at determining the atmospheric propagation conditions are described. The techniques of activity emission through a reactor exhaust air stack and of sampling at emission points, and the method of calculating the propagation factor, are described in detail. (auth)

41451 TENTATIVE METHOD OF ANALYSIS FOR ^{131}I CONTENT OF THE ATMOSPHERE (PARTICULATE FILTER: CHARCOAL GAMMA). Shleien, B.; Heatherton, R. G.; Hildebrandt, P. F.; Lockhart, L. B. Jr.; Morse, R. S.; Stein, W.; Van Farowe, D. F.; Hull, A. Health Lab. Sci.; 7: Suppl., 108-11(Jan 1970).

Radioactive iodine may be introduced into the atmosphere as an elemental or chemically combined vapor, as a vapor adsorbed on particulate matter, or as a particulate iodine compound. It thus presents a unique sampling problem. The proposed method involves sampling iodine in its solid and gaseous states with an absolute particulate filter in series with an activated charcoal cartridge. The ^{131}I activity is then quantitatively determined by gamma spectroscopy. Iodine adsorbed on solid particles and possibly some vaporous iodine will be deposited on the absolute filter while the remaining vaporous iodine will be adsorbed on the activated charcoal. Samples may be collected continuously for a week or more at low flow rates for routine environmental surveillance or for 24 hr or less at a high flow rate in order to evaluate a suspected or known incident. The sensitivity and range of detection, sources of interference, precision and accuracy of the technique, apparatus required, sampling and counting procedures, calibration standards, and calculations required for this technique are all discussed. (E.R.B.)

Mineralogy and Exploration

Refer also to abstract 41425.

41452 ISOTOPIC COMPOSITION OF LITHIUM IN URANIUM MINERALS. Levskii, L. K.; Murin, A. N.; Zaslavskii, V. G. At. Energ. (USSR); 28: 349-50(Apr 1970). (In Russian).

A previous study reported a significant change in the isotopic composition of lithium in uranium minerals. An attempt was made to confirm this finding by the investigation of two uraninite, one samarskite, and one thorite mineral. It was presumed that the isotopic enrichment in Li-7 would be a result of the neutron irradiation of B-10 by the following reaction: B−10 + n → Li−7 + alpha. The ratio of boron to lithium atom should be about 10^5 in order to obtain satisfactory agreement between the calculated and experimental values observed. Boron was determined by a fluorescence method, and lithium by flame photometry. The results on the four minerals showed that the ratio of boron to lithium atoms was about one. A mass-spectroscopic analysis of the lithium in the mineral samples by a thermionic emission method showed no enrichment in lithium isotopes. (TTT)

41453 PRESENT STATUS OF URANIUM PROSPECTING IN NEW MEXICO, USA. Com. Naz. Energ. Nucl., Notiz.; 16: No. 5, 86-8(May 1970). (In Italian).

An extensive review of the present status of prospecting in New Mexico, which is one of the largest uranium producers, is given with tables and ore deposit maps. (auth)

41454 PRODUCTION, RESERVES, AND FUTURE SOURCES OF URANIUM. Kostuik, J. (Denison Mines Ltd., Toronto). Trans. Can. Inst. Mining Met.; 72: 146-50(1969).

The outlook for uranium resources, and the measures needed to meet market objectives are discussed. Areas of recent exploration interest are also discussed. (auth) (Canada)

41455 GEOLOGY AND URANIUM DEPSOITS OF THE BLIND RIVER AREA, ONTARIO. Robertson, J. A. (Ontario Dept. of Mines, Toronto). Trans. Can. Inst. Mining Met.; 72: 156-71 (1969).

The results of a continuing investigation begun in 1953 by government geologists and mining companies are presented. Previous work is reviewed and the development of several stratigraphic nomenclatures and correlation schemes is traced, culminating with the interim report of the Federal-Provincial Committee on Huronian Stratigraphy formed in 1966. The stratigraphy, structure and correlation of the Huronian rocks of the Blind River area and the region between Sault Ste. Marie and Sudbury are reivewed. The area is underlain by three Precambrian units: (1) the Archean greenstones and granites, (2) the Huronian sedimentary and volcanic rocks and (3) the post-Huronian intrusive rocks. The Huron-rocks, largely quartzite and conglomerate with greywackes, argillites and carbonates, were laid down in shallow water transgressing over the eroded Archean basement. Thickness and facies changes indicate a northwesterly source, northerly overlap and deposition controlled by basement topography. Polymictic conglomerates, occurring at least at three horizons, represent tillites and are associated with varvites with dropped clasts. These are best developed in the Gowganda formation, which varies from a continental glacial environment in the north to a marine glacial environment in the southeast. There were at least three phases of post-Huronian igneous activity, probably related to several periods or phases of late Precambrian deformation and metamorphism: (1) sills of Nipissing diabase and rather younger diabase dikes; (2) the Cutler Granite and Croker Island Complex; and (3) dikes of Keweenawan olivine diabase. Copper mineralization is associated with the Nipissing diabase. The uranium ores are found in pyritic quartz-pebble conglomerate near the Huronian

Archean unconformity, particularly in ancient valleys; they are considered to be placer deposits modified by later events. Uranium production from the Blind River camp to the end of 1966 was 128,160,096 pounds U_3O_8 valued at $1,203,840,848 derived from 56,077,179 tons of ore grading 0.11 per cent U_3O_8. Within the Blind River and adjacent areas, future discoveries will probably be the result of costly systematic deep-drilling programs accompanied by detailed geologic studies of the type carried out by oil companies and probably computer-oriented. (auth)

Oceanography

Refer also to abstract 41562.

41456 (AD-704877) INSTRUMENTATION RESEARCH FOR RADIATION MEASUREMENTS IN THE MARINE ENVIRONMENT. Final Report, November 1, 1963-October 31, 1969. Folsom, T. R. (Scripps Institution of Oceanography, La Jolla, Calif.). 10 Apr 1970. Contract Nonr-2216(22). 22p. (SIO-Ref-70-15). CFSTI.

Six years of research on minute traces of natural and artificial radioactivities in the ocean and in other natural environments and materials is summarized. (auth) (USGRDR)

41457 (NVO-289-7) AMCHITKA TSUNAMI STUDY. Final Report. Tetra Tech Report TC-177. Hwang, Li-San; Divoky, David; Yuen, Albert (Tetra Tech, Inc., Pasadena, Calif.). Jun 1970. Contract AT(26-1)-289. 95p. Dep. CFSTI.

A study was undertaken to determine the potential tsunami hazard from a hypothetical, large, natural earthquake in the vicinity of Amchitka Island. It is presumed that such earthquakes are inevitable, whether or not connected with nuclear testing. It was also assumed that direct tsunami generation by ground motion due to cavity expansion during such tests is not possible. The steps used to approach the problem are described. As a result of the study, a successful computer code that realistically describes the source development was evolved. Other conclusions reached were that the wave pattern from a comparatively simple source has a complex nature, that the wave energy is radiated in a direction normal to the major axis of an elongated source, and that it is necessary to extend the grid matrix to all complex shorelines to explain the details of local wave action. (L.C.L.)

Seismology

Refer also to abstracts 41479, 41521-41524, 41527, and 41547.

41458 (AWRE-O-46/70) SOME SEISMIC RESULTS OF THE US GASBUBBY AND RULISON UNDERGROUND NUCLEAR EXPLOSIONS. Shot Report No. 3. Corbishley, D. J. (Atomic Weapons Research Establishment, Aldermaston (England)). Jun 1970. 10p. Dep. CFSTI (U. S. Sales Only). UK 2s.

GASBUGGY and RULISON were two nuclear explosions detonated underground by the United States AEC as part of Project Plowshare. These experiments were carried out jointly with commercial companies to investigate the feasibility of releasing natural gas from comparatively impervious (tight) strata. The seismic results obtained from the four UKAEA sponsored arrays at Eskdalemuir (EKA), Scotland; Yellowknife (YKA), Canada; Gauribidanur (GBA), India and Warramuga (WRA) near Tennant Creek, Australia are presented. (auth)

41459 (CGS-746-5) SEISMIC ACTIVITY IN SEPTEMBER 1969 NEAR THE RULISON NUCLEAR TEST SITE. Navarro, R.; Brockman, S. R. (Coast and Geodetic Survey, Rockville, Md.). 15 Jun 1970. 19p. (PNE-R-32). Dep. CFSTI.

Seismic activity in the vicinity of Project Rulison was monitored before and after the Sept. 10, 1969 detonation. No earthquakes were detected within 100 km of Rulison during the pre-event period of Sept. 3 to Sept. 10. The detection equipment and procedures, the calibration of the detection systems, and the methods used to calculate the magnitudes of shock waves from the detonation are discussed. Preliminary results indicate that the Rulison device behaved as expected, i.e., with a yield of about 40 Kt. The largest local post-shot shock had an approximate Richter magnitude of 2.3 and occurred on Sept. 13, 1969. (L.C.L.)

41460 (CONF-700101-(Vol.2), pp 1118-35) MAGNITUDE DETERMINATION FOR LARGE UNDERGROUND NUCLEAR EXPLOSIONS. Porter, Lawrence D. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

A method is presented for determining the local magnitudes for large underground nuclear explosions. The Gutenberg-Richter nomograph is applied to the peak amplitudes for 24 large underground nuclear explosions that took place in Nevada. The amplitudes were measured at 18 California Wood-Anderson stations located 150 to 810 km from the explosion epicenter. The variation of the individual station magnitudes and magnitude corrections and the variation of the average and rms error estimates in the magnitude determinations are examined with respect to distance, azimuth, and event location. The magnitude prediction capability of the Gutenberg-Richter nomograph is examined on the basis of these two criteria, and certain corrections are suggested. The azimuthal dependence of the individual station magnitudes is investigated, and corrections for the California stations are calculated. Statistical weighting schemes for two-component data are employed, and the assumptions and limitations on the use of peak amplitudes are discussed. (auth)

41461 (CONF-700101-(Vol.2), pp 1136-49) COMPRESSIONAL SEISMIC WAVES RECORDED DURING UNDERGROUND NUCLEAR EXPLOSION TESTS IN HOGGAR. Ferrieux, Henri (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

The seismic measurement device consisted of a movable apparatus in the shot area, and at larger distances, two stations at permanent places. The radial compression wave is examined from the beginning of the pseudo-elastical behaviour of the medium to a distance of fifty kilometers. The amplitude laws evolution conformed to the theory predictions. The shots energy and the observation distance influence on the amplitude spectra of the compression waves was studied. (auth)

41462 (CONF-700101-(Vol.2), pp 1150-9) DIRECTIVITY OF SEISMIC RADIATION FROM A SERIES OF LINE CHARGES. Ahrens, Thomas J. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

A series of two-dimensional calculations describing the stress wave propagation from a row of line explosive sources, detonated sequentially at a supersonic phase velocity on the surface of various layered (half-space) crustal models, was carried out. Spectral ratios of the resulting free-surface velocities at a series of hypothetical seismic stations were used to calculate directivity functions. As in the case considered earlier by Ben-Menahem (where the source moved subsonically), strong enhancement of certain frequencies in the spectrum of the horizontal component of velocity was obtained. Directivity is especially prominent when the explosion-induced signals are generated in a medium in which the longitudinal elastic wave velocity is comparable to the detonation phase velocity and when the seismic signal being analyzed has been refracted from a higher-velocity, underlying layer. (auth)

41463 APPLICATIONS OF DETECTION AND ESTIMATION THEORY TO LARGE ARRAY SEISMOLOGY. Capon, Jack (Lincoln Lab., Lexington, Mass.). Proc. IEEE (Inst. Elec. Electron. Eng.); 58: 760-70(May 1970).

The statistical theory of signal detection and estimation has been applied to problems in large array seismology. Using this theory the structure of the optimum detector for a known signal and long observation time in additive Gaussian noise is derived. The array processing filter employed by the optimum detector is known as the maximum-likelihood filter. This filter also has the property that it provides a minimum-variance unbiased estimate for the input signal when it is not known, which is the same as the maximum-likelihood estimate of the signal if the noise is a multidimensional Gaussian process. A series of experiments was performed using data from the large aperture seismic array to determine the effectiveness of the maximum-likelihood method relative to simpler methods such as beam-forming. These results provide significant conclusions regarding the design and processing of data from large seismic arrays. The conventional and high-resolution estimation of the frequency-wave number spectrum of the background microseismic noise is also presented. The diffuse structure of this spectrum is shown to aid in explaining the relative performance of array processing methods. (auth)

41464 EARTHQUAKE PREDICTION OR MODIFICATION. Kovach, Robert L. (Stanford Univ., Calif.). Comments Earth Sci. Geophys.; 1: 14-19(Jun-Jul 1970).

Considerations involved in the prediction of earthquakes are discussed and some of the limitations due to a lack of knowledge of the earthquake mechanism are mentioned. Seismic activity induced by nuclear explosions and the use of nuclear explosions to release tectonic strain are considered. (W.D.M.)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 41418, 41433, 41434, 41458–41462, and 42552.

41465 (AD–704608) HIGH-ALTITUDE BLAST GENERATION SYSTEM. PART II. DESIGN AND ECONOMIC STUDY. Final Report. Klima, Richard J.; Balcerzak, Marion J. (General American Transportation Corp., Niles, Ill. General American Research Div.). Dec 1967. Contract DA-49-146-XZ-573. 114p. (DASA–2303-2). CFSTI.

A program was conducted to determine the technical and economic feasibility of a high altitude blast generation system using detonable gases contained in balloons. The purpose of this system would be to produce a blast and shock environment at altitudes of up to 100,000 feet for in-flight missile and aircraft vulnerability testing and for atmospheric nuclear blast detection studies. Attention was given to the balloon design, the gas handling system, the launch and handling equipment, the effects instrumentation and flight control, the instrumentation recovery system and possible test sites required to physically implement this blast and shock generation technique. Cost estimates to field a single test ranged from $191,460 for a one ton explosive yield equivalent to 50,000 feet to $317,200 for a twenty ton yield at 50,000 feet. (auth) (USGRDR)

41466 (CEA-R–3968) USE OF NUCLEAR EXPLOSIONS TO IMPROVE THE PRODUCTIVITY OF OIL OR GAS BEARING STRATA. Delort, Francis; Supiot, Francis (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). May 1970. 43p. (In French). Dep. CFSTI (U. S. Sales Only).

Underground nuclear explosions in the Hoggar test site show that the geological effects may be favorable for the stimulation of oil or gas reservoirs. The study of the permanent liquid flow rate by DUPUIT equation shows that the flow rate may be increased by a factor of 10 to 50 for high yield explosions. Simultaneous explosions may have a more important stimulation action. (auth) (France)

41467 (CEA-R–3990) UNDERGROUND NUCLEAR EXPLOSIONS. STUDY OF MINERALOGICAL TRANSFORMATIONS. RESULTS FROM THE SAHARA TEST SITE. Faure, Jean (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Jun 1970. 40p. (In French). Dep. CFSTI (U. S. Sales Only).

The energy produced in rocks following an underground nuclear explosion can lead to important mineralogical changes, and causes the temperature to rise. On the Sahara test site, an extensive study was made of samples obtained by drilling. This made it possible to classify the observed transformations and to obtain data concerning the thermal evolution of the surroundings. (auth) (France)

41468 (CONF-700101–(Vol.1)) SYMPOSIUM ON ENGINEERING WITH NUCLEAR EXPLOSIVES, LAS VEGAS, NEVADA, JANUARY 14–16, 1970. PROCEEDINGS. (American Nuclear Society, Hinsdale, Ill. Atomic Energy Commission, Washington, D. C.). May 1970. 858p. Dep. CFSTI.

Forty-nine papers on engineering with nuclear explosives presented at the conference are included in Vol. 1. Separate abstracts were prepared for 39. Ten were previously abstracted in NSA. For abstracts of these see CONF-700101 in the Report Number Index. (L.C.L.)

For abstracts of individual papers see: 41469–41507.

41469 (CONF-700101–(Vol. 1). pp 1–4) IMPROVING THE QUALITY OF LIFE: CAN PLOWSHARE HELP? Thompson, Theos J. (Atomic Energy Commission, Washington, D. C.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The research advances achieved in the Plowshare Program, the contributions which nuclear energy can make toward protecting and improving the environment, and the possible uses of underground nuclear explosives for harbor construction, natural resource development, and underground storage space excavation are outlined as an introduction to the conference on engineering with nuclear explosives. (L.C.L.)

41470 (CONF-700101–(Vol.1), pp 5–12) THE FUTURE OF PLOWSHARE. Kelly, John S. (Atomic Energy Commission, Washington, D. C.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The present status and future of the Plowshare Program are discussed briefly, and the need for developing definitive programs for natural gas production stimulation and oil recovery from oil shales using underground nuclear explosions, is emphasized. (L.C.L.)

41471 (CONF-700101–(Vol.1), pp 13–23) AN INDUSTRIAL VIEW OF THE PLOWSHARE PROGRAM. Smith, Sam (El Paso Natural Gas Co., Tex.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Industry's evaluation of the Plowshare Program is presented. The increasing consumer demand for the earth's natural resources emphasizes the need for Plowshare applications. The difficulties of reconciling the benefits of natural resource production using underground nuclear engineering with the necessity of preserving and enhancing the quality of our environment are discussed. The basic needs of industry for developing underground nuclear engineering are listed and include recommendations for greater government-industry cooperation in defining authority, setting policies, disseminating information, providing safety criteria, and supplying budgetary support. (L.C.L.)

41472 (CONF-700101–(Vol.1), pp 24–8) NUCLEAR EXPLOSIVE DEVELOPMENT. Groseclose, B. Clark (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The development of nuclear explosives for Plowshare application, i.e., excavation, underground engineering, and heavy element production, is discussed. It is concluded that: nuclear explosives have been and can be designed especially for Plowshare applications; up to this time, excavation has received the major emphasis, and the excavation explosive will be in an excellent position for actual utilization if our presently scheduled experiments for this year are successfully carried out; an explosive especially designed for hydrocarbon stimulation has not been tested, but the current paper studies show that some designs are very promising and a tested design leaving a very small amount of post-explosion tritium could be available within a year of commencing hardware effort; and a device to provide a very high neutron flux has been successfully tested, and the continuation of device design effort in this area depends on the scientific value of the information obtainable from such experiments. A continuing program of device development is needed to assure the optimum explosive for each application at each point in time. (auth)

41473 (CONF-700101–(Vol.1), pp 29–42) UNDERGROUND NUCLEAR EXPLOSIONS. Higgins, Gary H. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

In the Third Plowshare Symposium, held in 1964, data from a number of nuclear explosions were presented. At that time the basic elements of the nuclear explosion appeared to be well understood and relationships for predicting the gross nuclear effects were presented. Since that time, additional work has been done and many of the concepts have been extended. For example, nuclear explosions have been conducted at greater depths and with much greater yields. The physical and chemical properties of the material in which the explosions occur have been more accurately measured and related to explosion effects. Interpretation of the new information seems to indicate that the earlier relationships are valid over the ranges of energy and depths for which data is available but that effects relating to cavity and chimney sizes or fracturing had been overestimated at great depths of burst and higher yields. (auth)

41474 (CONF-700101–(Vol.1), pp 43–65) ENGINEERING EFFECTS OF UNDERGROUND NUCLEAR EXPLOSIONS. Boardman, Charles R. (CER Geonuclear Corp., Las Vegas, Nev.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Useful effects of contained underground nuclear explosions are discussed in light of today's most promising potential applications. Relevant data obtained through exploration of explosion environments of nine U. S. tests in competent rock are summarized and presented as a practical basis for estimating magnitudes of effects. Effects discussed include chimney configuration, permeability, and volume as well as rubble particle size distributions and extents of permeability change in the chimney wall rock. Explosion mediums include shale, granite, dolomite, and salt. (auth)

41475 (CONF-700101–(Vol.1), pp 68-74) EMPLACEMENT ENGINEERING. Hill, Ernest E. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Emplacement engineering can be defined as that portion of a nuclear explosive project that is concerned with the emplacement of the explosive, and includes virtually everything except the design and fabrication of the explosive and the post-shot-effects program. The emplacement portion of a nuclear explosive project constitutes a large fraction of the total project cost, but it has largely been overshadowed by the explosive and explosive-effects portions. As commercial applications develop emplacement engineering must receive more attention from both industry and government. To put emplacement costs in their proper relation to total projects costs, commercial underground nuclear explosive applications such as gas stimulation were studied, and an estimate of the relative fractional costs of the non-explosive costs compared with the explosive costs was obtained. This study involved estimating the cost elements for applications using a single explosive at 5,000 ft, 10,000 ft, and 15,000 ft. For each depth, the cost estimates were made for a range of emplacement hole and explosive diameters. The results are presented as plots of cost versus emplacement hole diameter. (L.C.L.)

41476 (CONF-700101–(Vol.1), pp 75-88) SUMMARY OF GEONUCLEAR EFFECTS. Rawson, Donald E. (Gulf General Atomic Inc., San Diego, Calif.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Geonuclear effects are considered here to include all of the interactions between underground nuclear explosions and the surrounding earth material. They constitute a large spectrum of effects that starts with the complex chemistry of the explosion "fireball" and continues in space until the teleseismic signals in the earth have attenuated and in time until the radioactive products have decayed. Those effects which are of direct use to possible nonexcavation engineering projects and the major side effects that could detract from the use of nuclear explosions for such projects are discussed. Emphasis is given to possible methods of enhancing the desired geonuclear effects and minimizing the deleterious ones. (auth)

41477 (CONF-700101–(Vol.1), pp 89-109) LOADING–UNLOADING PRESSURE: VOLUME CURVES FOR ROCKS. Stephens, D. R.; Lilley, E. M. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The stress-strain codes (SOC and TENSOR) used to calculate phenomenology of nuclear explosion for the Plowshare Program require inter alia the pressure-volume relationships of the earth media. A rapid and accurate method to obtain pressure-volume data to 40 kb at 25°C for rocks is described. These experimental results may also be related to the in situ elastic properties of the rock and to other laboratory measurement of properties, such as ultrasonic experiments with pressure and Hugoniot determinations. Qualitative features of the pressure-volume curves can be related to the initial porosity of the rock. A porous rock is usually quite compressible at low pressures. If the porosity is in the form of narrow cracks, the cracks are closed at a pressure of about 3 to 6 kb, after which the rock is much less compressible. If the porosity is in the form of spherical pores, it is not necessarily removed even at pressures of 40 kb, depending on the strength of the rock, and the compressibility is higher at all pressures than for a similar rock containing no porosity. Data for water-saturated samples show the phase transformation due to free water at about 10 and 22 kb. However, the presence of "nonliquid" water, which is loosely contained within the lattice of clay or zeolitic minerals or adsorbed on particle surfaces, is also observed. (auth)

41478 (CONF-700101–(Vol.1), pp 110-26) DYNAMIC ELASTIC MODULI OF ROCKS UNDER PRESSURE. Schock, R. N. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Elastic moduli are determined as a function of confining pressure to 10 kb on rocks in which Plowshare shots are to be fired. Numerical simulation codes require accurate information on the mechanical response of the rock medium to various stress levels in order to predict cavity dimensions. The theoretical treatment of small strains in an elastic medium relates the propagation velocity of compressional and shear waves to the elastic moduli. Velocity measurements can provide, as unique code input data, the rigidity modulus, Poisson's ratio and the shear wave velocity, as well as providing checks on independent determinations of the other moduli. Velocities are determined using pulsed electromechanical transducers and measuring the time-of-flight in the rock specimen. A resonant frequency of 1 MHz is used to ensure that the wavelength exceeds the average grain dimension and is subject to bulk rock properties. Data obtained on a variety of rock types are presented and analyzed. These data are discussed in terms of their relationship to moduli measured by static methods as well as the effect of anisotropy, porosity, and fractures. In general, fractured rocks with incipient cracks show large increases in velcoity and moduli in the first 1 to 2 kb of compression as a result of the closing of these voids. After this, the velocities increase much more slowly. Dynamic moduli for these rocks are often 10% higher than corresponding static moduli at low pressure, but this difference decreases as the voids are closed until the moduli agree within experimental error. The discrepancy at low pressure is a result of the elastic energy in the wave pulse being propagated around cracks, with little effect on propagation velocity averaged over the entire specimen. (auth)

41479 (CONF-700101–(Vol.1), pp 142-220) NUMERICAL SIMULATION OF STRESS WAVE PROPAGATION FROM UNDERGROUND NUCLEAR EXPLOSIONS. Cherry, J. T.; Petersen, F. L. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

A numerical model is presented of stress wave propagation (SOC) which uses material properties data from a preshot testing program to predict the stress-induced effects on the rock mass involved in a Plowshare application. SOC calculates stress and particle velocity history, cavity radius, extent of brittle failure, and the rock's efficiency for transmitting stress. The calculations are based on an equation of state for the rock, which is developed from preshot field and laboratory measurements of the rock properties. The field measurements, made by hole logging, determine in situ values of the rock's density, water content, and propagation velocity for elastic waves. These logs also are useful in judging the layering of the rock and in choosing which core samples to test in the laboratory. The laboratory analysis of rock cores includes determination of hydrostatic compressibility to 40 kb, triaxial strength data, tensile strength, Hugoniot elastic limit, and, for the rock near the point of detonation, high-pressure Hugoniot data. Equation-of-state data are presented for rock from three sites subjected to high explosive or underground nuclear shots, including the Hardhat and Gasbuggy sites. SOC calculations of the effects of these two shots on the surrounding rock are compared with the observed effects. In both cases SOC predicts the size of the cavity quite closely. Results of the Gasbuggy calculations indicate that useful predictions of cavity size and chimney height can be made when an adequate preshot testing program is run to determine the rock's equation of state. Seismic coupling is very sensitive to the low-pressure part of the equation of state, and its successful prediction depends on agreement between the logging data and the static compressibility data. In general, it appears that enough progress has been made in calculating stress wave propagation to begin looking at derived numbers, such as number of cracks per zone, for some insight into the effects on permeability. A listing of the SOC code is appended. (auth)

41480 (CONF-700101–(Vol.1), pp 221-9) THEORETICAL MODEL OF THE EARLY PHASES OF AN UNDERGROUND EXPLOSION. Cameron, I. G.; Scorgie, G. C. (Atomic Weapons Research Establishment, Aldermaston (England)).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

In the early phases of the intense underground explosions contemplated in peaceful applications, the rock near the explosive exhibits fluid behavior; at great distances its behavior can usefully be investigated in terms of linear elasticity; and at intermediate distances as a solid exhibiting various inelastic effects including cracking and tensile fracture. A mathematical model that attempts to include in some degree the main features of this range of behavior is outlined. A computer program ATHENE, was written based on this model and its use is illustrated by examining some aspects of two types of explosions. One is a chemical explosion which eventually formed a crater and the other a nuclear explosion which remained wholly contained. (auth)

41481 (CONF-700101–(Vol.1), pp 230-9) COMPUTATION OF FLUID FLOW IN DISTENDING TUNNELS WITH MASS, MOMENTUM AND ENERGY EXCHANGE WITH THE WALLS. Maw, J. R. (Atomic Weapons Research Establishment, Aldermaston (England)).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

When calculating the effects of an underground explosion it may

be useful to be able to calculate the flow of the very hot gaseous products along pipes or tunnels. For example it might be possible to treat a fault in the surrounding rock as an idealised pipe forced open by the high pressure generated by the explosion. Another possibility might be the use of a specially constructed tunnel to channel the energy released in some preferred direction. In such cases the gas flow is complicated by several phenomena. The cross section of the pipe may vary with axial distance and also distend with time. Heat will be lost to the walls of the pipe which may be ablated leading to entrainment of wall material into the gas flow. In addition wall friction will tend to retard the flow. A simple computer program, HAT, which was written to calculate such flow is described. The flow is assumed to be quasi-one-dimensional in that flow quantities such as pressure density and axial velcoity do not vary across the pipe. However the radius of the pipe may vary both with axial distance and with time. Sources or sinks of mass, momentum and energy are included in the governing equations which allow simulation of the phenomena described above. The governing equations are derived in Eulerian form and approximated using an extension of the finite difference scheme of Lax. A brief outline of the computational procedure is given. To demonstrate the capabilities and assess the accuracy of the program two simple problems are calculated using HAT: the motion of a shock along a converging pipe; and the effect of mass addition through the walls on the motion of a shock along a uniform pipe. In both cases results obtained using HAT are compared with theoretical analyses of the motion. (auth)

41482 (CONF-700101-(Vol.1), pp 240-4) THE FRENCH EXPERIMENTATION AT THE UNDERGROUND NUCLEAR TESTING SITE IN THE SAHARA DESERT. Gauvenet, Andre (Commissariat a l'Energie Atomique, Paris (France)).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

The experience gained from the underground nuclear tests which took place in the Sahara desert from 1961 to 1966 are briefly summarized, and present studies being carried on in France on the peaceful uses of nuclear explosions are reviewed. (L.C.L.)

41483 (CONF-700101-(Vol.1), pp 245-79) SUMMARY OF NUCLEAR-EXCAVATION APPLICATIONS. Toman, John (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

Although many nuclear-excavation applications have been proposed, few have been seriously considered and none have been brought to fruition. These applications are summarized and specific examples of a canal, a harbor, a highway cut and a nuclear quarry, all of which have been studied in some detail are discussed. It is believed that useful demonstration projects — such as a deep-water harbor and a nuclear quarry — can be safely accomplished with existing technology. Current assessments of the feasibility of constructing a sea-level canal in either Panama or Colombia appear to be favorable from a technical viewpoint. The concept of close spacing in row-charge designs has made it possible to greatly reduce the estimated required salvo yields for both proposed canals. Salvo yields have been reduced from 35 Mt to 13 Mt in Colombia and 11 Mt in Panama. As a result, the seismic motions predicted for large cities in these countries are similar to motions produced in populated areas in the United States by nuclear tests and earthquakes in which no real damage to residential or high-rise structures was noted. (auth)

41484 (CONF-700101-(Vol.1), pp 280-93) STATUS OF THE INTEROCEANIC CANAL STUDY. Groves, R. H. (Atlantic-Pacific Interoceanic Canal Study Commission, Washington, D. C.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

The status of an engineering study to determine the feasibility of constructing a transisthmian sea-level canal by conventional and nuclear construction methods is reviewed. This study considered 6 possible routes and the geologic conditions along these routes, the technical problems of conventional and nuclear excavation, and the estimated construction costs using both methods individually and in combination. The study should be completed by Dec. 1970. Current conclusions are that a conventionally constructed canal is feasible and that nuclear excavation methods look promising. (L.C.L.)

41485 (CONF-700101-(Vol.1), pp 294-305) NONPROLIFERATION TREATY AND PEACEFUL USES OF NUCLEAR EXPLOSIVES. Ehrlich, Thomas (Stanford Univ., Calif. School of Law).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

The development and provisions of the Nonproliferation Treaty and its significance to peaceful uses of nuclear explosives are discussed. (L.C.L.)

41486 (CONF-700101-(Vol.1), pp 306-33) RESULTS OF THE SCHOONER EXCAVATION EXPERIMENT. Tewes, Howard A. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

Project Schooner, a nuclear detonation in interlayered hard and soft, partially saturated volcanic rock, was executed as a part of the Plowshare Program for development of nuclear excavation techniques. The primary objectives of this experiment were: to obtain experimental data on crater development and size in a new medium to further verify existing rock mechanics computer codes and calculational techniques; and to determine the fractional release of radioactivity from a nuclear detonation in wet rock. As was noted in the case of the Sedan experiment, appreciable (though relatively small) amounts of radioactivity were released to the environment from this detonation in hard, partially saturated rock. Although the thermonuclear explosive used in this experiment gave a yield of approximately 31 kilotons, only the equivalent of the fission products from about 370 tons of fission were distributed in both fallout and cloud. Data which have been reduced to date indicate that this released radioactivity underwent only a moderate amount of chemical fractionation, being much more similar in this respect to Sedan than to Danny Boy. (auth)

41487 (CONF-700101-(Vol.1), pp 334-59) NUCLEAR CRATERING ON A DIGITAL COMPUTER. Terhune, R. W.; Stubbs, T. F.; Cherry, J. T. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

Computer programs based on the artificial viscosity method are applied to developing an understanding of the physics of cratering, with emphasis on cartering by nuclear explosives. Two established codes, SOC (spherical symmetry) and TENSOR (cylindrical symmetry), are used to illustrate the effects of variations in the material properties of various media on the cratering processes, namely shock, spall, and gas acceleration. Water content is found to be the most important material property, followed by strength, porosity, and compressibility. Crater profile calculations are presented for Pre-Gondola Charley (20-ton nitromethane detonation in shale) and Sedan (100-kt nuclear detonation in alluvium). Calculations also are presented for three 1-Mt yields in saturated Divide basalt and 1-Mt yield in dry Buckboard basalt, to show crater geometry as a function of the burial depth for large explosive yields. The calculations show, for megaton-level yields, that gas acceleration is the dominate mechanism in determining crater size and depends in turn on the water content in the medium. (auth)

41488 (CONF-700101-(Vol.1), pp 360-74) EXCAVATION RESEARCH WITH CHEMICAL EXPLOSIVES. Vandenberg, William E.; Day, Walter C. (Army Engineer Nuclear Cratering Group, Livermore, Calif.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

The U. S. Army Engineer Nuclear Cratering Group (NCG) was established in 1962 primarily to perform chemical explosive excavation experiments to provide preliminary data for planned nuclear excavation experiments. The present and future chemical explosive excavation experiments conducted by NCG are planned so as to provide data that can be used in the development of both chemical and nuclear excavation technology. In addition, whenever possible, the experiments are conducted at the specific sites of authorized Civil Works Construction Projects and are designed to provide useful work for that project. Currently the emphasis in the chemical explosive excavation program on the development of design techniques for producing specific crater geometries in a variety of media. Preliminary results of two such experiments, Project Pre-GONDOLA III, Reservoir Connection Experiment, and a safety calibration series for Project TUGBOAT are described. (L.C.L.)

41489 (CONF-700101-(Vol.1), pp 375-80) RADIOACTIVITY FROM PLOWSHARE APPLICATIONS: SAFETY CONSIDERATIONS. Tewes, H. A. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

Safety considerations related to the release of radioactivity from Plowshare applications of both contained and excavation nuclear explosions are discussed with particular reference to the radiological safety program undertaken by the USAEC to determine the distribution of radioactivity from underground nuclear explosions, to reduce the amount of radioactivity re-

leased to the environment from such explosions, and to understand the impact of this radioactivity on the biosphere. (L.C.L.)

41490 (CONF-700101–(Vol.1), pp 400-21) POSTSHOT DISTRIBUTION AND MOVEMENT OF RADIONUCLIDES IN NUCLEAR CRATER EJECTA. Koranda, John J.; Martin, John R.; Wikkerink, Robert; Stuart, Marshall (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The distribution and postshot movement of radionuclides in nuclear crater ejecta are discussed. Continuing studies of tritium movement in ejecta at Sedan crater demonstrate that variations in tritium concentration are correlated with seasonal rainfall and soil water movements. Losses of 17 mCi H^3/ft^2 are evident on Sedan crater lip at the end of a three year period of measurements in which an unusually large flux of rain was received. The distribution of gamma emitting radionuclides and tritium is described in the recently created Schooner crater ejecta field. The specific activity of radionuclides in the Schooner ejecta continuum is shown for ejecta collected from the crater lip to 17 miles from GZ. The movement of ^{181}W and tritium into the sub-ejecta preshot soil is described at a site 3000 feet from GZ. (auth)

41491 (CONF-700101–(Vol.1), pp 422-38) RADIOECOLOGICAL STUDIES OF TRITIUM MOVEMENT IN A TROPICAL RAIN FOREST. Martin, J. R.; Jordan, C. F.; Koranda, J. J.; Kline, J. R. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Several experiments on the movement of tritium in a tropical ecosystem have been conducted in the montane rainforest of Eastern Puerto Rico. Tritiated water was used as a tracer for water movement in: mature evergreen trees of the climax rainforest; soil and substory vegetation; and rapidly growing successional species. In the tree experiment, tritiated water was injected directly into several species of mature, broad leaved evergreen tropical trees. Transpiration and residence time for tritium was determined from analyses of leaves sampled during a several month period. Transpiration ranged from 4 ml/day/gm dry leaf for an understory Dacryodes excelsa to 10.0 and 13.8 ml/day/gm dry leaf for a mature Sloanea berteriana and D. excelsa, respectively. Mean residence time for the S. berteriana was 3.9 ± 0.2 days and the understory and mature D. excelsa values were 9.5 ± 0.4 and 11.0 ± 0.6 days, respectively. In another experiment, tritiated water was sprinkled over a 3.68 m^2 plot and its movement down into the soil and up into the vegetation growing on the plot was traced. The pattern of water movement in the soil was clearly demonstrated. The mean residence time for tritium in the soil and in trees was found to be 42 ± 2 days and 67 ± 9 days, respectively. The residence time for tritium in the trees in this experiment was considerably longer than for the single injected input pulse due to the continuous root uptake of tritium as the diffuse peak moved down into the soil past the root zone. Tritium was removed from the plot by transpiration and by interflow. Using transpiration rates from the previous experiment, rainfall records, tree density data and other measurements, average transpiration for the Puerto Rico rainforest was computed to be 3.64 $kg/m^2/day$. The effective capacity of the soil compartment was calculated to be 280 ± 12 kg/m^2. In the final experiment, tritiated water was injected directly into several species of successional trees in a cleared plot. After several weeks, the trees were harvested and aliquotes selected for bound tritium assay. The amount of tritium incorporated into the tissue was about 0.1 percent of the total amount applied to the tree. Based on all experimental data, the distribution of tritium from a simulated rainout following a one megaton thermonuclear detonation is presented for a climax tropical rainforest and for successional vegatation. The fraction of input tritium remaining in each compartment as a function of time is tabulated. The residence time for each of the compartments determines the persistence of tritium deposited in a tropical ecosystem. (auth)

41492 (CONF-700101–(Vol.1), pp 439-62) SUMMARY OF USSR REPORTS ON MECHANICAL AND RADIOACTIVITY EFFECTS OF UNDERGROUND NUCLEAR EXPLOSIONS. Kruger, Paul (Stanford Univ., Calif. Dept. of Civil Engineering).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Two reports issued by the USSR on the mechanical effects and radioactive contamination of the environment from underground nuclear explosions are summarized. The basic parameters which affect the mechanical effects are listed, and the validity of using these parameters to determine the mechanical effects of both chemical and nuclear explosions is examined. The phenomology of radioactive contamination of the environment from both contained and excavation nuclear explosions is discussed. Fallout data from US and USSR tests are presented. (L.C.L.)

41493 (CONF-700101–(Vol.1), pp 463-80) CAVITY PRESSURE HISTORY OF CONTAINED NUCLEAR EXPLOSIONS. Chapin, C. E. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Knowledge of pressure in cavities created by contained nuclear explosions is useful for estimating the possibility of venting radioactive debris to the atmosphere. Measurements of cavity pressure, or temperature, would be helpful in evaluating the correctness of present code predictions of underground explosions. In instrumenting and interpreting such measurements it is necessary to have good theoretical estimates of cavity pressures. Cavity pressure is estimated at the time when cavity growth is complete. Its subsequent decrease due to heat loss from the cavity to the surrounding media is also predicted. The starting pressure (the pressure at the end of cavity growth) is obtained by adiabatic expansion to the final cavity size of the vaporized rock gas sphere created by the explosion. Estimates of cavity size can be obtained by stress propagation computer codes, such as SOC and TENSOR. However, such estimates require considerable time and effort. Instead cavity size is estimated using a scheme involving simple hand calculations. The prediction is complicated by uncertainties in the knowledge of silica water system chemistry and a lack of information concerning possible blowoff of wall material during cavity growth. If wall material blows off, it can significantly change the water content in the cavity, compared to the water content in the ambient media. After cavity growth is complete, the pressure will change because of heat loss to the surrounding media. Heat transfer by convection, radiation and conduction is considered, and its effect on the pressure is calculated. Analysis of cavity heat transfer is made difficult by the complex nature of processes which occur at the wall where melting, vaporization and condensation of the gaseous rock can all occur. Furthermore, the melted wall material could be removed by flowing or dripping to the cavity floor. It could also be removed by expansion of the steam contained in the melt (blowoff) and by thermal stress fractures at the melt-solid interface. There are three distinct heat transfer regimes, depending on the temperature of the cavity gas. When the cavity gas temperature is greater than the temperature at which wall material is removed by melting or blowoff, heat transfer occurs with mass removal. The water contained in the removed wall material is added to the cavity gas. As the cavity temperature decreases, due to the heat loss, a temperature will be reached where the gaseous rock condenses. Thereafter, the gas is composed entirely of steam. Heat transfer during condensation is the second heat transfer regime. Following condensation the cavity gas will continue to cool, and material will continue to be removed from the walls as before. However, when the cavity cools sufficiently, the wall material becomes extremely viscous. Further heat transfer takes place by conduction into the walls. The heat transfer rate will be considerably reduced when this occurs since rock is a rather poor conductor of heat. Heat transfer by conduction is the third heat transfer regime. A parametric study of pressure histories in contained underground nuclear explosions is made and the results of the calculations are compared with the limited experimental data available. (auth)

41494 (CONF-700101–(Vol.1), pp 481-92) THERMODYNAMICS OF THE SILICA-STEAM SYSTEM. Krikorian, Oscar H. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

In most nuclear cratering and cavity formation applications, the working fluid in the expanding cavity consists primarily of vaporized silica and steam. The chemical reaction products of silica and steam under these conditions are not known, although it is known that silica is very volatile in the presence of high-pressure steam under certain geologic conditions and in steam turbines. A review is made of work on the silica-steam system in an attempt to determine the vapor species that exist, and to establish the associated thermodynamic data. The review indicates that at 600 to 900°K and 1 to 100 atm steam pressure, $Si(OH)_4$ is the most likely silicon-containing gaseous species. At 600 to 900°K and 100 to 1000 atm steam, $Si_2O(OH)_6$ is believed to predominate, whereas at 1350°K and 2000 to 9000 atm, a mixture of $Si(OH)_4$ and $Si_2(OH)_6$ is consistent with the observed volatilities. In work at 1760°K in which silica was reacted either with steam at 0.5 and 1 atm, or with gaseous mixtures of H_2/H_2O and O_2/H_2O at 1 atm total pressure, only part of the volatility could be accounted for by $Si(OH)_4$. Hydrogen was found to greatly enhance the volatility of silica, and oxygen to suppress it. The species most likely to explain this behavior is believed to be SiO(OH). A number of other species may also be significant

under these conditions. Thermodynamic data have been estimated for all species considered. The Si–OH bond dissociation energy is found to be ~117 kcal/mole in both $Si(OH)_4$ and $Si_2O(OH)_6$. (auth)

41495 (CONF-700101–(Vol.1), pp 493-504) COMMENTS ON SOME OF THE PHYSICAL CHEMICAL QUESTIONS ASSOCIATED WITH THE ANALYSIS OF WATER IN EARTH MATERIALS. Catalano, Edward (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

A discussion of various physical chemical questions which are associated with the quantitative analysis of water in earth materials is presented. A pseudothermodynamic approach to the binding of water in various types of earth materials is also presented. Emphasis is placed on the fact that as pore, crack, or hole sizes approach molecular dimensions, the interaction energy of water with the host material can become very large. A scale of interaction energies is suggested which would be useful for specifying operationally relevant analyses in earth materials. (auth)

41496 (CONF-700101–(Vol.1), pp 505-18) UNDERGROUND NUCLEAR EXPLOSION EFFECTS IN GRANITE ROCK FRACTURING. Derlich, S. (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

On the Saharian nuclear test site in Hoggar granite, mechanical properties of the altered zones were studied by in situ and laboratory measurements. In situ methods of study are drillings, television, geophysical and permeability measurements. Fracturing is one of the most important nuclear explosion effects. Several altered zones were identified. There are: crushed zone, fractured zone and stressed zone. Collapse of crushed and fractured zone formed the chimney. The extent of each zone can be expressed in terms of yield and of characteristic parameters. Such results are of main interest for industrial uses of underground nuclear explosives in hard rock. (auth)

41497 (CONF-700101–(Vol.1), pp 519-44) ESTIMATING THE SIZE OF THE CAVITY AND SURROUNDING FAILED REGION FOR UNDERGROUND NUCLEAR EXPLOSIONS FROM SCALING RULES. Rogers, Leo A. (El Paso Natural Gas Co., Tex.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The fundamental physical principles involved in the formation of an underground cavity by a nuclear explosion and breakage of the rock surrounding the cavity are examined from the point of view of making preliminary estimates of their sizes where there is a limited understanding of the rock characteristics. Scaling equations for cavity formation based on adiabatic expansion are reviewed and further developed to include the strength of the material surrounding the shot point as well as the overburden above the shot point. The region of rock breakage or permanent distortion surrounding the explosion generated cavity is estimated using both the Von Mises and Coulomb–Mohr failure criteria. It is found that the ratio of the rock failure radius to the cavity radius for these two criteria becomes independent of yield and dependent only on the failure mechanics of the rock. The analytical solutions developed for the Coulomb–Mohr and Von Mises criteria are presented in graphical form. (auth)

41498 (CONF-700101–(Vol.1), pp 545-59) SCALING CRITERIA FOR ROCK DYNAMIC EXPERIMENTS. Crowley, Barbara K. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

A set of necessary conditions for performing scaled rock dynamics experiments is derived from the conservation equations of continuum mechanics. Performing scaled experiments in two different materials is virtually impossible because of the scaling restrictions imposed by two equations of state. However, performing dynamically scaled experiments in the same material is possible if time and distance use the same scaling factor and if the effects of gravity are insignificant. When gravity becomes significant, dynamic scaling is no longer possible. To illustrate these results, example calculations of megaton and kiloton experiments are considered. (auth)

41499 (CONF-700101–(Vol. 1), pp 560-6) NUCLEAR ECOLOGY OR CAN A LIBERAL BE A CONSERVATIONIST? Teller, Edward (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The conflict between conservationists who have become reactionary and progressives who believe that technical advances can be made without damaging our environment is reviewed with emphasis on the ecological effects of peaceful uses of reactors and nuclear explosives. The ecological effects discussed include thermal pollution and radioactive contamination. The envisioned uses include power production, natural gas production, opening of geothermal reservoirs, nuclear mining, and the construction of canals, harbors, and larger underground and under-seabed storage spaces. It is concluded that progress will be made in using nuclear energy for peaceful purposes, but that the rate of progress will depend on enlightened and unfrightened attitudes by those with the power to control this progress. (L.C.L.)

41500 (CONF-700101–(Vol.1), pp 567-76) HYDROCARBON PRODUCTION WITH NUCLEAR EXPLOSIVES. Watkins, J. Wade (Bureau of Mines, Washington, D. C.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The tremendous energy of nuclear explosives and the small dimensions of the explosive package make an ideal combination for drill-hole explosive emplacement in deep, thick hydrocarbon deposits. Potential applications exist in fracturing low premeability natural-gas and petroleum formations for stimulating production, fracturing oil shale to permit in situ retorting, and creating storage chimneys for natural gas, liquefied petroleum gas, petroleum, petroleum products, helium, and other fluids. Calculations show, for example, that less than 100 shots per year would be needed to stabilize the natural gas reserves to production ratio. Under the Government-industry Plowshare program, two experiments, Projects Gasbuggy and Rulison, were conducted to stimulate natural gas production from low-permeability formations. Incomplete information indicates that both were technically successful. Potential problems associated with the use of nuclear explosives for underground engineering applications are radioactive contamination, maximum yield limitations, high costs of detonating contained nuclear explosives, and adverse public opinion. Results at Project Gasbuggy and other considerations indicated that the problem of radioactive contamination was about as predicted and not an insurmountable one. Also, it was demonstrated that shots at adequate depths could be detonated without appreciable damage to existing surface and subsurface buildings, natural features, and equipment. However, costs must be reduced and the public must be better informed before these techniques can be widely used in field operations. On the basis of present knowledge, the potential of nuclear-explosive stimulation of hydrocarbon production appears good. Additional field experiments will be required to adequately explore that potential. (auth)

41501 (CONF-700101–(Vol.1), pp 629-48) ENGINEERING WITH NUCLEAR EXPLOSIVES NEAR POPULATED AREAS: A SURVEY FROM THE TECHNOLOGICAL AND ECONOMIC VIEWPOINT. Parker, K. (Atomic Weapons Research Establishment, Aldermaston (England)).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Current experience with underground firings of nuclear explosives and of large charges of conventional explosives is largely confined to sparsely populated areas such as the Nevada and Sahara deserts and parts of Siberia. On the other hand many of the commercial applications proposed for nuclear explosives are directly relevant to industrialized areas, where consumptions of energy and natural resources are high, as are population densities. In many of these areas there is a need to increase the efficiency with which natural gas, oil and electrical power are supplied and to make safe disposal of fluid wastes; completely contained nuclear explosions could be a useful tool in achieving some or all of these aims. While radioactivity and air blast hazards are likely to rule out nuclear cratering operations near densely populated areas, the prospects for carrying out completely contained explosions are much better, providing seismic damage is kept within reasonable bounds. In large areas of Western Europe and on the eastern, southern and western seaboards of the United States this might be achieved by using nuclear explosions beneath the seabed at a reasonable distance from the nearest coastline, always provided the relevant political issues can be resolved. Stimulation and storage of North Sea natural gas, construction of off-shore oil storage and storage of electrical energy are areas where engineering with nuclear explosives merits more detailed investigation and some of the relevant technical problems are discussed. (auth)

41502 (CONF-700101–(Vol.1), pp 649-61) NUCLEAR STIMULATION OF OIL-RESERVOIRS. Delort, F.; Supiot, F. (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Underground nuclear explosions in the Hoggar nuclear test site have shown that the geological effects may increase the production of oil or gas reservoirs. By studying the permanent liquid flow-rate with approximate DUPUIT's equation, or with a computer code, it is shown that the conventional well flow-rate may be increased by a factor between 3 and 50, depending on the medium and explosion conditions. (auth)

41503 (CONF-700101–(Vol.1), pp 753-74) STUDIES OF RADIOACTIVITY FROM NUCLEAR EXPLOSIONS FOR PEACEFUL PURPOSES. Siddons, R. A. (Atomic Weapons Research Establishment, Aldermaston (England)).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Estimates are made of the extent and duration of hazards from radioactivity to the general public due to fallout from a cratering explosion. The nuclear explosive is assumed to be "clean" in the sense that only a small fraction of the yield is derived from fission. Hypothetical examples take an explosive of total yield 100 kT, of which 10 kT, 1 kT and zero— the ultimate in cleanliness— are derived from fission. The maximum permitted level to the public is taken as 0.5 rem in a period of one year. Sources of activity considered are fission products, residual thermonuclear material (tritium), neutron induced activity in the device materials and neutron induced activity in the surrounding rock. Estimates of the production are made, and are associated with a distribution function derived from the Sedan fallout measurements. The hazards from radioactivity associated with the creation of a storage reservoir for natural gas have also been considered. In this case the main problem is contamination of the product by tritium left in the chimney. The possibility of flushing out this tritium with water is discussed. (auth)

41504 (CONF-700101–(Vol.1), pp 794-814) INTERPRETING THE CHEMICAL RESULTS OF THE GASBUGGY EXPERIMENT. Taylor, R. W.; Lee, E. L.; Hill, J. H. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Nuclear explosions in carbonate-bearing rocks release large amounts of CO_2. In some cases, for example, when the explosion is contained and dolomite is the principal carbonate mineral, sufficient CO_2 may be generated to drive the formation gas away from the chimney. Rocks which contain free carbon, such as the shales of the recent Gasbuggy and proposed Bronco and Dragon Trail experiments, will liberate CO and H_2 in amounts predicted from the yield of the explosive and the C, CO_2 and H_2O concentration in the rock. In general, the greater the amount of free carbon in a rock, the more H_2 will be produced and the higher will be the fraction of tritium in the gas phase. (auth)

41505 (CONF-700101–(Vol.1), pp 815-17) ADDITIONAL COMMENTS ON THE CHEMICAL RESULTS OF THE GASBUGGY EXPERIMENT. Duff, Russell E. (Applied Nuclear Co., La Jolla, Calif.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Gas in the Gasbuggy chimney was analyzed for chemical composition 36 days after the explosion. The results are compared with predictions on gas composition made using 2 theoretical models, one of which showed results in good agreement with the measured data. The assumptions and conditions used in this model are presented. Further verification of the results is recommended. (L.C.L.)

41506 (CONF-700101–(Vol.1), pp 831-49) PRELIMINARY ASSESSMENT OF THE RADIOLOGICAL IMPLICATIONS OF COMMERCIAL UTILIZATION OF NATURAL GAS FROM A NUCLEARLY STIMULATED WELL. Jacobs, D. G.; Struxness, E. G. (Oak Ridge National Lab., Tenn.); Bowman, C. R. (El Paso Natural Gas Co., Tex.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Widespread utilization of nuclear explosives, in conjunction with the natural gas industry, can result in radiatic n exposure of sizable population groups. It is prudent to make realistic assessments of such potential radiation exposures before they occur and, unless the expected exposures are clearly insignificant, to consider these exposures in evaluating the net benefit of this particular use of nuclear energy. All pertinent facts relating to such assessments should be made public and presented in such a way that those who are to assume the risks, if any, can make a reasonable judgment as to whether the risks are acceptable. Radioactivity in natural gas from the Gasbuggy cavity has been analyzed prior to and during flaring operations. None of this gas has entered the collection and distribution system, but a theoretical analysis has been made of the hypothetical impact on members of the public that would have occurred if the gas had been introduced into the commercial stream. Dose equivalents have been estimated for both workers and consumers. In this analysis, Gasbuggy gas has been traced through a real gas-collection system and processing plant, as represented by the present situation existing in the San Juan Production Division, El Paso Natural Gas Company. In addition, a number of considerations are presented which would apply to radiation exposure in metropolitan areas. Results of this analysis for the Gasbuggy well indicate hypothetical dose equivalents to various population groups to be well within the annual dose limits suggested by the International Commission on Radiological Protection. Projection to a steady-state situation involving extensive natural gas production from many producing wells also resulted in hypothetical dose equivalents within the annual dose limits. Simple extrapolation of the results from this analysis to potential exposures resulting from nuclear stimulation of other gas reservoirs cannot be made on a direct basis, but this method of evaluation should point to the potential exposure situations of greatest concern in any exploitation of this technique. (auth)

41507 (CONF-700101–(Vol.1), pp 850-8) STUDY OF CHEMICAL REACTIONS IN THE NUCLEAR UNDERGROUND EXPLOSION: INCIDENCE ON RADIOACTIVITY. Picq, Jean Maurice (Commissariat a l'Energie Atomique, Bruyers-le-Chatel (France). Centre d'Etudes).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The theoretical and semi-empirical laws governing the reaction of radioactivity in contained nuclear explosions were investigated. The chemical reactions during the different stages of cavity and chimney formation were studied as well as the heat transfer processes. Melted rock and gas samples taken from the French underground explosions were examined. Simulation apparatus based on inductive plasma was used to determine the pressures and temperatures undergone by granite and marble samples. The calculated and measured distribution of temperature in the rocks showed good agreement. Analysis of melted rocks from a nuclear explosion showed parts of the rock had no radioactivity; in the radioactive parts, α activity was homogeneous while β-γ activity was not and the latter seemed concentrated in bubbles within the melted rock. Large quantities of tritium appeared to be contained in the melted rocks. (L.C.L.)

41508 (CONF-700101–(Vol.2)) SYMPOSIUM ON ENGINEERING WITH NUCLEAR EXPLOSIVES, LAS VEGAS, NEVADA, JANUARY 14–16, 1970. PROCEEDINGS. (American Nuclear Society, Hinsdale, Ill. Atomic Energy Commission, Washington, D. C.). May 1970. 927p. Dep. CFSTI.

Sixty-two papers were presented at the conference and are included in Vol. 2. Separate abstracts were prepared for 58. Four were previously abstracted in NSA. For abstracts of these see CONF- 7001001 in the Report Number Index. (L.C.L.)

For abstracts of individual papers see: 41460–41462, 41509–41561, 43183, and 43312.

41509 (CONF-700101–(Vol.2), pp 859-63) SUMMARY PAPER ON NUCLEAR MINING. Michaelson, S. D. (Kennecott Copper Corp., Salt Lake City, Utah).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The 12 year progress of the Plowshare Program in developing nuclear mining applications is reviewed. The economic and technical problems associated with specific mining uses, i.e., ore breaking, in-situ leaching, and stripping overburden from low-grade deposits, are discussed. Further cooperation between industry and the AEC in planning and executing programs to use nuclear explosives to decrease mining costs and to increase metal supplies is urged. (L.C.L.)

41510 (CONF-700101–(Vol.2), pp 864-76) NUCLEAR TECHNOLOGY AND MINERAL RECOVERY. Stewart, Richard M.; Niermeyer, Karl E. (Anaconda Co., Salt Lake City, Utah).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The economics of recovering copper by the in-situ leaching of underground ores fractured by nuclear explosives are discussed in detail and include nuclear fracturing costs, acid costs, plant capital expenditures, labor, etc. Further experimental information is needed to prove the economic feasibility of the nuclear in-situ method for extracting copper. (L.C.L.)

41511 (CONF-700101–(Vol.2), pp 877-87) IN SITU RECOVERY OF COPPER FROM SULFIDE ORE BODIES FOLLOWING NUCLEAR FRACTURING. Rosenbaum, Joe B.; McKinney, W. A. (Bureau of Mines, Salt Lake City, Utah. Salt Lake City Metallurgy Research Center).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Leaching now yields about 12 percent of the Nation's annual new copper production. About 200,000 tons of copper a year is being won by heap and vat leaching of ore, dump leaching of waste, and in-place leaching of caved underground workings. Although in-place leaching was practiced as long ago as the 15th century, it is little used and contributes only a few percent of the total leach copper production. Despite its limited use, the concept of extracting copper by in-place leaching without physically mining and transporting the ore continues to present intriguing cost saving possibilities. Project SLOOP has been proposed as an experiment to test the feasibility of nuclear fracturing and acid leaching the oxidized portion of a deep ore body near Safford, Ariz. However, the bulk of the copper in deep ore deposits occurs as sulfide minerals that are not easily soluble in acid solutions. The concept of in-place leaching of nuclearly fractured, deeply buried copper sulfide deposits is explored. On the assumption that fracturing of rock and solution injection and collection would be feasible, an assessment is made of solution systems that might be employed for the different copper sulfide minerals in porphyry ore bodies. These include the conventional ferric sulfate-sulfuric acid systems and combinations of sulfide mineral oxidants and different acids. (auth)

41512 (CONF-700101–(Vol.2), pp 888-908) PARTICLE-SIZE DISTRIBUTION STUDY: PILEDRIVER EVENT. Rabb, David D. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Reentry was made by mining into the chimney of broken rock created by a nuclear detonation in granite at a depth of 1500 feet. The chimney was 160 ft in radius and 890 ft high. An injection of radioactive melt was encountered at 300 ft from shot point. Radiochemical analyses determined that the yield of PILEDRIVER nuclear device was 61 ± 10 kt. Two samples of chimney rubble totalling over 5,000 lb were obtained during the postshot exploration. These samples of broken granite underwent screen analysis, a radioactivity-distribution study, and cursory leaching tests. The two samples were separated into 25 different size-fractions. An average of the particle-size data from the two samples showed that 17% of the material is between 20 mesh and 1 in.; 42% between 1 and 6 in.; and 34% between 6 in. and 3 ft. The distribution of radioactivity varies markedly with the particle size. The minus 100-mesh material comprises less than 1.5% of the weight but contains almost 20% of the radioactivity. Small-scale batch-leaching tests showed that 25% of the radioactivity could be removed in a few hours by a film-percolation leach with distilled water, and 40% with dilute acid. Brief studies were made of the microfractures in the broken rock and of the radioactivity created by the PILE-DRIVER explosion. (auth)

41513 (CONF-700101–(Vol.2), pp 918-30) OVERBURDEN STRIPPING FROM DEEPLY BURIED OREBODIES BY CONTROLLED NUCLEAR EXPLOSIVE CASING. Saperstein, L. W.; Mishra, R. (Pennsylvania State University Park).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Previous schemes to strip the overburden from a deeply-buried orebody by nuclear explosives have been hampered by various constraints. These are the notions that surface topography should slope in the desired direction to facilitate casting; that the orebody should be stripped all at once, meaning that an unsafe and unnaturally high yield will be detonated; or that the overburden be broken and cast, in a manner akin to conventional blasting, with a series of explosions linked by milli-second delays, such delays being an unproven and, perhaps non-permissible technology; and, finally, that the schemes leave an excessive amount of overburden to be removed by conventional means. It is proposed that deep orebodies, idealized by a 250-ft. thick copper prophyry under 600 feet of cover, be stripped in successive rows, using available row-charge technology. A first row, of greater magnitude than those succeeding, is used to expose the orebody. The second row is placed so as to throw overburden into the void created by the first. All rows are placed so as not to damage the ore. Except for the first row, all rows utilize directed throwing. After a row is detonated, the ore beneath it would be removed by conventional means. The void thus created would provide space for the successive row to fire into. Further, the additional free-face provided by the void imparts a major direction to the ejecta. Because of the directed nature of the throw, ore removal does not have to proceed directly beneath the row slope. Advantages to this scheme are its adaptability to terrain; its reduction in overburden to be removed by conventional methods; its increased speed in uncovering ore; its reduction of unit costs; and its adaptability to production rates. An example, utilizing the idealized orebody shows that production of ore can begin within a year of project approval versus four or five years for the same orebody developed conventionally; that no more than eight percent of the overburden has to be handled conventionally; and that unit cost for overburden removal is about four cents per ton, which is a two to ten-fold reduction in present-day costs. (auth)

41514 (CONF-700101–(Vol.2), pp 931-7) NUCLEAR OPERATIONS SUMMARY ENGINEERING ORGANIZATION FOR PLOWSHARE NUCLEAR OPERATIONS. Broadman, Gene A. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The engineering organization used and the responsibilities of each group involved in the emplacement, detonation, and data acquisition activities of the Plowshare Program are presented. (L.C.L.)

41515 (CONF-700101–(Vol.2), pp 938-63) ENVIRONMENTAL CONTROL FOR NUCLEAR EXPLOSIVES. Lundberg, A. W.; Wells, W. H. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The effects of the emplacement environment on the design of nuclear explosive assemblies for both excavation and underground engineering uses are discussed with emphasis on the special problems of pressure and temperature. The emplacement environment conditions assumed for these studies were 1500 psi external pressure and 150°F ambient temperature for excavation explosives, and 20,000 psi external pressure and 450°F ambient temperature for deep underground engineering explosives. It was concluded that: nuclear explosives can be protected in very hostile environments with an additional diameter of about 10% of the overall diameter; canisters with the required characteristics can be built of conventional materials; and cooling systems can be developed having adequate performance. (L.C.L.)

41516 (CONF-700101–(Vol.2), pp 964-73) INTEGRATED CONTROL SYSTEM FOR NUCLEAR EXPLOSIVES. Ragsdale, William F. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The Integrated Control System (ICS) was developed to facilitate Plowshare nuclear detonations by following a unified system approach. This system consolidates the techniques for firing, safety program, scientific program, and communications. Maximum emphasis is placed upon control and data transmission by radio rather than hardwire or coaxial cable. (auth)

41517 (CONF-700101–(Vol.2), pp 974-8) EMPLACEMENT AND STEMMING OF NUCLEAR EXPLOSIVES FOR PLOWSHARE APPLICATIONS. Cramer, J. L. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Methods used for emplacing and stemming nuclear explosives used in Plowshare experiments and the design considerations associated with these methods are discussed. (L.C.L.)

41518 (CONF-700101–(Vol.2), pp 979-93) CONTROL OF THE DYNAMIC ENVIRONMENT PRODUCED BY UNDERGROUND NUCLEAR EXPLOSIVES. Bernreuter, D. L.; Jackson, E. C.; Miller, A. B. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Methods for shock mounting equipment used in the measurement of surface ground motions caused by underground nuclear explosions are discussed. (L.C.L.)

41519 (CONF-700101–(Vol.2), pp 994-1013) INTEROCEANIC CANAL EXCAVATION SCHEDULING VIA COMPUTER SIMULATION. Baldonado, Orlino C. (Holmes and Narver, Inc., Los Angeles, Calif.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The computer simulation language GPSS/360 was used to simulate the schedule of several nuclear detonation programs for the interoceanic canal project. The effects of using different weather restriction categories due to air blast and fallout were investigated. The effect of increasing the number of emplacement and stemming crews and the effect of varying the reentry period after detonating a row charge or salvo were also studied. Detonation programs were simulated for the proposed Routes 17A and 25E. The study

demonstrates the method of using computer simulation so that a schedule and its associated constraints can be assessed for feasibility. Since many simulation runs can be made for a given set of detonation program constraints, one readily obtains an average schedule for a range of conditions. This provides a method for analyzing time-sensitive operations so that time and cost-effective operational schedules can be established. A comparison of the simulated schedules with those that were published shows them to be similar. (auth)

41520 (CONF-700101–(Vol.2), pp 1014-23) RELIABILITY IMPLICATIONS FOR COMMERCIAL PLOWSHARE APPLICATIONS. Brumleve, T. D. (Sandia Labs., Albuquerque, N. Mex.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Based on the premise that there will always be finite chance of a Plowshare project failure, the implications of such a failure are examined. It is suggested that the optimum reliability level will not necessarily be the highest attainable, but rather that which results in minimum average project cost. The type of performance guarantee that the U. S. should provide for nuclear explosive services, the determination of nuclear yield, courses of action to take in the event of failure, and methods to offset remedial costs are discussed. (auth)

41521 (CONF-700101–(Vol.2), pp 1024-50) EXPLOSION-PRODUCED GROUND MOTION: TECHNICAL SUMMARY WITH RESPECT TO SEISMIC HAZARDS. Rodean, Howard C. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The present technical knowledge, experimental and theoretical, of how underground nuclear explosions produce seismic motion that may be a hazard at distances measured in tens of kilometers is summarized. The effects of explosion yield and rock properties (at the explosion, along the signal propagation path, and at the site where a hazard may exist) on the ground motion are described in detail, and some consideration is given to the relation between ground motion and damage criteria. (auth)

41522 (CONF-700101–(Vol.2), pp 1051-68) PREDICTION OF SEISMIC MOTION FROM CONTAINED AND EXCAVATION NUCLEAR DETONATIONS. Mueller, R. A. (Environmental Research Corp., Alexandria, Va.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Capability to predict ground motions from nuclear events is developed on empirical and theoretical bases. Analyses of the experimental data provide basic predictions of peak particle motions and spectra which follow a $(\text{yield})^{m}$ times $(\text{distance})^{-n}$ relationship. The exponents on yield and distance are frequency dependent and derived from experiment and theory. Theory provides a physical understanding of the phenomena which allows extrapolation to off-NTS and atypical events. For example, yield scaling theory predicts significantly higher frequency motions and consequently larger ground accelerations for overburied events such as Gasbuggy, Rulison, Wasp and Wagon Wheel. These conclusions are observed from Gasbuggy (26 kt) which generated ground accelerations comparable to a normal buried event of 200 kt. This result is important in avoiding personal injury and assessing the probability of property damage. Conversely, theory predicts lower ground accelerations and seismic efficiencies for excavation events; these effects are observed from the Cabriolet and Schooner events and consequently predicted for the Sturtevant and Yawl events. With regard to the distance exponent, scattering theory determines a distance exponent which predicts greater attenuation effects on higher frequency motions. This trend is verified experimentally by regression analyses on a large number of data points which determine the distance exponent to range from −1.1 at low frequencies to −1.6 at high frequencies. Results indicate that cube root similarity scaling is not appropriate in the far field except possibly for peak particle displacements at the low frequency end of the spectrum. In addition to the source and transmission factors, current ground motion prediction techniques, on and off-NTS, take into account local site characteristics. Experimental evidence and theoretical models — layered media elastic theory, finite element modeling, and building response modeling — demonstrate local geology and structural amplifications of ground motions. (auth)

41523 (CONF-700101–(Vol.2), pp 1095-1102) ORIGINS OF DISPLACEMENTS CAUSED BY UNDERGROUND NUCLEAR EXPLOSIONS. Rinehart, John S. (Colorado Univ., Boulder).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Elastic theory has been used to calculate the relative displacement that will occur between the two sides of a loose boundary when a plane wave strikes the boundary obliquely. The calculations suggest that the displacements produced along loose fractures and faults close in to the underground nuclear explosions are a direct consequence of reflection of the transient stress wave at this loose boundary. Quantitatively the results agree fairly well with the limited data that are available. (auth)

41524 (CONF-700101–(Vol.2), pp 1103-17) ON THE PREDICTION OF BUILDING DAMAGE FROM GROUND MOTION. Blume, John A. (Blume (John A.) and Associates, Research Div., San Francisco, Calif.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

In the planning of a nuclear event it is essential to consider the effects of the expected ground motion on all exposed buildings and other structures. There are various steps and procedures in this process which generally increase in scope and refinement as the preparations advance. Initial, rough estimates, based upon rules-of-thumb and preliminary predictions of ground motion and structural response, may be adequate to show general feasibility of the project. Subsequent work is done in both the field and analysis phases, to estimate the total structure exposure, to isolate special hazards, and to make damage cost estimates. Finally, specific analyses are made of special buildings or structures to identify safety problems and to make recommendations for safety measures during the proposed event. Because the ground motion and the structural response both involve many random variables and therefore some uncertainties in prediction, the probabilistic aspects must be considered, both on a broad statistical basis and for specific safety considerations. Decisions must be made as to the acceptability or non-acceptability of the risks and any indicated procedures before and during the event to reduce or to eliminate the risks. Various techniques involved in these operations including the Spectral Matrix Method of damage prediction, the Threshold Evaluation Scale for specific building analysis, and the inelastic and probabilistic aspects of the problem are discussed. (auth)

41525 (CONF-700101–(Vol.2), pp 1160-3) REVIEW: WATER RESOURCES DEVELOPMENT. Todd, David K. (California Univ., Berkeley).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Information gathered during the past 15 years relative to the possible uses of nuclear explosives in water resources management is briefly reviewed. The applications include the construction of canals, dams, harbors, reservoirs, recreation areas, and waste storage spaces and the use of nuclear craters for ground-water recharge. The problems associated with such uses of nuclear explosives, including the comparative cost of conventional construction methods, the radiological and seismic hazards, legal limitations, geologic and hydrological considerations, and the effects on water quality are mentioned. It is concluded that such uses of nuclear explosives are economically and technically feasible and can be demonstrated. (L.C.L.)

41526 (CONF-700101–(Vol.2), pp 1164-8) NUCLEAR EXPLOSIVES IN WATER-RESOURCE MANAGEMENT. Piper, Arthur M. (Geological Survey, Washington, D. C.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Nuclear explosives afford diverse tools for managing our water resources. These include principally: the rubble column of a fully contained underground detonation, the similar rubble column of a retarc, the crater by subsidence, the throwout crater of maximum volume (the latter either singly or in-line), and the ejecta of a valley-slope crater. By these tools, one can create space in which to store water, either underground or on the land surface — in the latter instance, to a considerable degree independently of the topography. Underground, one can accelerate movement of water by breaching a confining bed, a partition of a compartmented aquifer, or some other obstruction in the natural "plumbing system." Finally, on the land surface, one can modify the natural pattern of water flow, by canals excavated with in-line detonation. In all these applications, the potential advantage of a nuclear explosive rests chiefly in undertakings of large scale, under a consequent small cost per unit of mechanical work accomplished. (auth)

41527 (CONF-700101–(Vol.2), pp 1169-73) PROJECT AQUARIUS: CONTROL OF RADIOISOTOPES AND SAFETY. Post, Roy G. (Arizona Univ., Tucson. Dept. of Nuclear Engineering).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The radiological and seismic effects of the proposed use of nuclear explosives to construct a dam at the Clear Creek site in Arizona were investigated. It was concluded that, due to the

unpopulated nature of the area, seismic nor blast effects damage would result from the explosions. It is believed that all radioisotopes other than tritium would readily be contained in the soils. More specific data to confirm this must be obtained in order to provide assurance to the public that the project is radiologically safe. (L.C.L.)

41528 (CONF-700101-(Vol.2), pp 1174-83) PROJECT AQUARIUS: GEOHYDROLOGIC INVESTIGATION. Ganus, William J. (Arizona Univ., Tucson).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

Piper and Stead (1965) suggested several potential applications of nuclear explosives in the development and management of water resources. The Aquarius study began with an investigation of these potential applications in Arizona. The three district physiographic provinces of Arizona offered a wide range of geohydrologic settings for study of modification by nuclear explosives. Damming of surface water by bulking techniques including rock quarrying, was considered the most favorable application for analysis. A general discussion of geologic and hydrologic conditions for a canyon site in North-central Arizona is given. Groundwater recharge by cratering in alluvial materials is rated as the second most favorable application and a site in Southeastern Arizona, representative of a typical alluvial fan setting, is discussed. Other applications are presented but hold less promise due to lack of geohydrologic and nuclear explosion data necessary for proper evaluation. In the review of potential sites for study, primary consideration was given to distance of site from population centers and to the quantity of water that could be developed and managed. For surface water resource development by nuclear explosions, additional considerations for site selection included canyon meanders necessary for diversion channels, low permeable rock types for minimizing problems of radioisotope migration, and a clear identification of any groundwater system that could be affected. In the site selection for recharge craters, considerations included adequate subsurface storage space, aquifer characteristics favorable to recharge and recovery, subsurface lithologic type and distribution that would permit control of radioisotopes by either monitoring or removal, suspended sediment load of water source, and estimated increased efficiency of artificial recharge over natural recharge. (auth)

41529 (CONF-700101-(Vol.2), pp 1184-97) AQUARIUS STUDY: ENGINEERING AND ECONOMIC CONSIDERATIONS. Griffin, Roger F. (Bechtel Corp., San Francisco, Calif.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

The engineering and economic considerations involved in developing and evaluating three concepts for constructing a rock-fill dam at the Clear Creek site in northern Arizona are presented. The concepts include nuclear quarrying, throwout damming, and retarc damming. Cost estimates for conventional and nuclear methods of dam construction are compared. It was concluded that the potential for using nuclear explosives in dam construction are sufficiently attractive to warrant further development. (L.C.L.)

41530 (CONF-700101-(Vol.2), pp 1198-1221) MECHANICS OF SLIDE DAMS. Young, G. A. (Agbabian-Jacobsen Associates, Los Angeles, Calif.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

The problems associated with the construction of slide dams with nuclear explosives are discussed. First, the characteristics of conventional earth- and rock-fill dams are examined using empirical data from many years of experience. The characteristics of natural landslide dams are also briefly considered to identify potential problems that must be overcome by slide dam construction techniques. Second, the mechanics of slide dams as determined from small-scale laboratory studies are presented. It is concluded that slide dams can be constructed and that small-scale field tests and additional laboratory studies are justified. (auth)

41531 (CONF-700101-(Vol.2), pp 1222-45) USE OF A RUBBLE CHIMNEY FOR DENITRIFICATION OF IRRIGATION RETURN WATERS. Evans, Roy B.; Kruger, Paul (Stanford Univ., Calif. Dept. of Civil Engineering).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

The feasibility of using a rubble chimney created by a contained nuclear explosion as a biological filter for removing nitrates from irrigation return waters was investigated. In the process, waste water is introduced at the bottom of the filter, methol is added as an energy source for the reduction reaction, the nitrates are reduced to nitrites, the nitrites are reduced to nitrogen gas which is released to the atmosphere, and the denitrified water is removed from the top of the chimney. The treatment of irrigation return waters in the San Joaquin Valley of California was used as an example. The studies investigated the effects of rubble particle size and chimney pressure and temperature on the denitrification process, the annual amount of irrigation water which should require treatment, the environmental effects of radioactivity produced by the explosion, and the costs of constructing and operating such a rubble chimney filter system. It was concluded that irrigation return water treatment with rubble chimney filters is technically feasible, that the construction costs in the San Joaquin Valley compare favorably with such costs for alternative processes, and that the rubble chimney filter system is advantageous in that it produces no odors and it requires very little surface land for equipment. However, the cost of constructing the inlet and outlet tubes is high, and pumping costs represent a major operating expense. Further experiments must be performed to determine the biological solids retention in rubble materials, to verify the effects of pressure and temperature on the denitrification process, and to measure the rate of leaching of radioactivity from a chimney containing large amounts of biological solids. (L.C.L.)

41532 (CONF-700101-(Vol.2), pp 1246-52) PRESENT STATUS OF SCIENTIFIC APPLICATIONS OF NUCLEAR EXPLOSIONS. Cowan, G. A.; Diven, B. C. (Los Alamos Scientific Lab., N. Mex.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

The current uses of nuclear explosions as fast neutron sources for experimental purposes are discussed. The use of these sources in synthesizing nuclei and in neutron cross-section measurements is briefly mentioned. The outlook for future work along these lines is summarized. (J.W.R.)

41533 (CONF-700101-(Vol.2), pp 1253-6) USE OF NUCLEAR EXPLOSIVES IN MEASUREMENT OF NUCLEAR PROPERTIES OF FISSILE MATERIALS. Diven, B. C. (Los Alamos Scientific Lab., N. Mex.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

The use of small underground nuclear explosions as neutron sources for measurements of neutron cross sections for fissile materials is described. The techniques used in measuring fission, capture, and scattering cross sections are surveyed. The time-of-flight method used in most experiments is examined. Some prospects for future measurements are mentioned. (J.W.R.)

41534 (CONF-700101-(Vol.2), pp 1269-82) PRODUCTION OF HEAVY NUCLIDES IN NUCLEAR DEVICES. Eccles, Samuel F. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

Since the last Plowshare Symposium in 1964 a number of experiments have been carried out to study the production of heavy nuclei by rapid multiple neutron capture in specially designed nuclear devices. The main characteristics of these experiments are higher neutron fluxes than in the early events; a variety of targets, including ^{238}U, ^{242}Pu, ^{237}Np, ^{243}Am, ^{232}Th; the occurrence of an interesting "reversal of the odd-even effect" in the mass yield curves; and the absence of nuclei in the debris with (Z, A) greater than (100,257). Analysis of data from these experiments have led to capture cross sections for neutron-rich uranium isotopes (out to ^{249}U), and capture-to-fission ratios for the odd-A neutron-rich plutonium isotopes (out to ^{253}Pu). General studies of the fission process in neutron-rich nuclei have also been undertaken using the data from these experiments. The large amounts of ^{250}Cm and ^{257}Fm made in the recent Hutch experiment ($\sim 1 \times 10^{20}$ and $\sim 5 \times 10^{17}$ atoms, respectively) make it scientifically exciting, and economically feasible, to mine and recover enough material to produce laboratory targets of these isotopes. These targets would be used in investigations of yet-undiscovered, short-lived isotopes of Fm, Md, and No, as well as the possible production of new isotopes of element 104 and even element 105. (auth)

41535 (CONF-700101-(Vol.2), pp 1283-94) RECOVERY AND STUDY OF HEAVY NUCLIDES PRODUCED IN A NUCLEAR EXPLOSION: THE HUTCH EVENT. Hoff, R. W.; Hulet, E. K. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

During the explosion of the Hutch device, the target (^{238}U and ^{232}Th) was subjected to a very high neutron exposure, 2.4×10^{25} neutrons/cm^2. Multiple neutron capture reactions resulted in the production of heavy nuclides, up to and including ^{257}Fm. Results of the search for species with $A > 257$ were negative. The recovery and chemical processing of kilograms of Hutch debris has resulted in the isolation of 10^{10} atoms of ^{257}Fm, which is 10^2

times more material than has been available for experimentation in the past. Experimentally significant amounts of other rare nuclides, e.g., ^{254}Cf, ^{251}Cf, ^{255}Es, and ^{250}Cm, have also been separated from the Hutch debris. The production of these nuclides in thermonuclear explosions is shown to be a valuable supplement to the AEC program for reactor production of transplutonium elements. The neutron flux achieved in Hutch was insufficient to even approach production of nuclides in the region of ^{298}114. A much more intense neutron flux is required. In future experiments, considerable attention must be given to the problem of adequate sample recovery, in order to properly use the ability to subject targets to an exceedingly intense time-integrated neutron flux. (auth)

41536 (CONF-700101–(Vol.2), pp 1295-1305) THERMONUCLEAR NEUTRON SOURCES: A NEW ISOTOPE PRODUCTION TECHNOLOGY. Heckman, Richard A. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

With the successful detonation of the Hutch device, we have demonstrated the feasibility of a new isotope production technique. The exposure of a ^{238}U and ^{232}Th target to an extremely large neutron flux, 1.8×10^{25} neutrons/cm^2, produced super-heavy nuclides up to ^{257}Fm by the multiple neutron capture process. Kilogram quantities of Hutch debris were recovered by a modification of standard drilling techniques. A semicontinuous batch process was used to concentrate approximately 10^{10} atoms of ^{257}Fm from approximately 50 kg of debris. Experience from the Hutch debris recovery efforts indicates that significant engineering advances in recovery techniques and subsequent cost reductions are possible. The demonstrated success of the device clearly justifies an engineering development program. Comparing debris recovery by underground mining operations with recovery using possible advances in drilling technology does not indicate an obvious cost advantage of one system over the other. Possible advances in mining technology could change this tentative conclusion. Any novel schemes for debris concentration that might be possible through an understanding of underground nuclear detonation phenomenology would also radically affect recovery and processing economics. A preliminary process engineering design of a large-scale (a few hundred to a few thousand kilograms) processing facility located at the Nevada Test Site will be discussed. Cost estimates for isotopes produced in this facility will be described. The effects of debris concentration "ore" beneficiation, and total debris processed on unit costs will be discussed. These preliminary estimates show that this new isotope "production" scheme would be competitive with existing reactor facilities. (auth)

41537 (CONF-700101–(Vol.2), pp 1315-21) REVIEW OF POSSIBLE PEACEFUL APPLICATIONS OF NUCLEAR EXPLOSIONS IN THE NATIONAL ECONOMY OF THE SOVIET UNION. Witherspoon, Paul A. (California Univ., Berkeley).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The current thinking of Soviet scientists and engineers on the possibilities of using nuclear explosions for peaceful purposes in the Soviet Union is reviewed. Aside from a very brief review of one explosion in salt no details on nuclear explosion effects (mechanical, seismic, radiation, or thermal) are given. Rather, the results of design calculations are summarized and the direction of Soviet planning for a variety of industrial applications are indicated. (auth)

41538 (CONF-700101-(Vol.2), pp 1322-42) WHY NUCLEAR GEOSTORAGE SYSTEMS FOR PETROLEUM? van der Harst, L.; Knutson, C. F. (CER Geonuclear Corp., Las Vegas, Nev.). From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

The objective of any kind of storage system in general is to act as a buffer between cyclical changes in supply and demand of the stored commodities. Since the advent of nuclear explosives engineering the possibility of constructing large-scale underground storage systems by means of contained nuclear explosions, for which the name nuclear geostorage has been coined, should be regarded as a valid alternative to the conventional storage systems currently in existence. Limiting this discussion to systems for storing crude oil, various options are available. The choice of any particular storage method depends, of course, on the circumstances surrounding each particular storage requirement; however, in many cases and for a variety of reasons, nuclear geostorage can be preferable to conventional solutions. Economic considerations are clearly among the most important ones. In this respect an increase in storage capacity will tend to favor the nuclear approach. Besides the economics, however, other considerations are important and may in some cases swing the balance in favor of nuclear geostorage plants, for instance: safety and strategic values, aesthetics, ease of access, lack of suitable tank farm space or lack of suitable geologic conditions for natural reservoirs. It should be borne in mind that the decision to use the nuclear approach to solve a storage problem can only be taken after satisfactory evaluation of the geological and geographical characteristics of the site, and when the technical, safety, political, and public relations factors can be handled adequately. (auth)

41539 (CONF-700101–(Vol.2), pp 1343-63) TECHNICAL CONSIDERATIONS FOR PLOWSHARE APPLICATIONS TO OIL SHALE. Lombard, David B. (California Univ., Livermore. Lawrence Radiation Lab.); Bray, Bruce G. (CER Geonuclear Corp., Las Vegas, Nev.); Sohns, Harold W. (Bureau of Mines, Laramie, Wyo.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Nuclear explosions have been proposed for use in the recovery of oil from deep oil shale deposits. Before commercial feasibility can be established, a variety of technical problems must be examined. Some of these are related to nuclear explosion effects, others to the recovery of oil from the broken rock. Among the primary areas of interest are fracturing, chimney collapse, rubble size distribution, radioactivity, and retorting methods and variables. To test the concept, nuclear explosion experiments will be needed. One such experiment, Project Bronco, has been designed in detail, and is used here to illustrate a possible direction of development. The design is based on the following objectives: to evaluate the overall feasibility of nuclear breaking, followed by in situ retorting; to investigate the gross physical effects of a nuclear explosion in oil shale, and to assess the role of radioactivities in the production of oil by in situ retorting. The experimental plan provides for the accomplishment of these objectives by appropriate preshot studies, a postshot examination of explosion effects, and experimental retorting of the nuclear chimney. (auth)

41540 (CONF-700101–(Vol.2), pp 1364-75) OIL SHALE RESEARCH RELATED TO PROPOSED NUCLEAR PROJECTS. Carpenter, H. C.; Sohns, H. W.; Dinneen, G. U. (Bureau of Mines, Laramie, Wyo.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The Bureau of Mines is conducting research to develop data pertinent to in situ retorting of oil shale fractured by a nuclear explosion or other means. Maximum utilization of the Green River oil shale found in Colorado, Utah, and Wyoming, at depths ranging from outcrops to several thousand feet, requires development of several methods of processing. Early research was devoted to developing processes for application to oil shale occurring at depths suitable for mining. In present research, the emphasis is on in situ retorting and recovery processes that would be more satisfactory for oil shales occurring at greater depths. Development of an in situ process depends upon finding or establishing sufficient permeability in the oil shale beds for the passage of fluids which serve as a heat carrier in bringing the oil shale to retorting temperature. Use of a nuclear explosive seems to offer the best chance for successfully fracturing the thicker and more deeply buried portions of the deposit to give the required permeability. Processing the very large quantity of broken and fractured oil shale that would be produced presents many problems which require new background data for their solution. This paper describes research the Bureau of Mines is conducting to develop pertinent data. Primarily this research involves laboratory determination of properties of oil shale, pilot scale investigation of retorting characteristics of ungraded broken shale, and underground combustion of shale fractured by pressure and chemical explosives. Application of the research results should aid in designing the oil recovery phase and provide an estimate of the quantity of oil that may be obtained in a nuclear experiment in oil shale. (auth)

41541 (CONF-700101–(Vol.2), pp 1376-83) ECONOMICS OF PLOWSHARE GEOTHERMAL POWER. Burnham, J. B.; Stewart, D. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The technical feasibility and economics of using underground nuclear explosions to create cavities in which geothermal energy would produce steam which in turn could be used to generate electricity, is discussed. One example of the magnitude of this energy source can be had by considering that the energy available from one of the smallest of Oregon's geothermal areas is equivalent to the energy resource of the North Slope oil pool. The method includes creating a cavity in deep hot rock, introduction of water into the bottom of the cavity, and removal of steam from the cavity top

to power the generators. The radiological hazards in the closed cycle system are minimal. The seismic safety of the explosions must be considered. Estimates are given of the explosive emplacement costs, capital expenditures required, total power costs, and the relative power costs for different sizes of explosions. It is concluded that the large potential that geothermal power has as another major energy source warrants a more in-depth feasibility study and a demonstration experiment to prove the practicality of the concept. (L.C.L.)

41542 (CONF-700101–(Vol.2), pp 1384-5) ON THE USE OF NUCLEAR EXPLOSIVES FOR STIMULATION OF GEOTHERMAL HEAT. Nordyke, Milo D. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Many areas of the world exist where high temperature isotherms supported by heat flow from the core of the earth occur very close to the surface of the earth. Commercial exploitation of these sources of energy has only recently become practical and is limited to those areas where a natural system of fracture acts to collect heat from a large volume of rock and sufficient natural water is available to act as a heat transfer agent. Recent studies have indicated many more areas of geothermal heat are available than had been identified previously. The nuclear application envisages the creation of a chimney and associated fracture system with a nuclear explosion, introduction of water into the chimney-fracture system, and removal of superheated steam for the generation of electrical power. Three phenomena are considered: utilization of the heat content of the rock in the chimney and fracture zone; heat flow from the surrounding medium to the fracture zone or chimney by conductivity; and interconnection of a preexisting network of fracture by the highly permeable chimney and fracture zone. A 1-Mt example is examined showing that over 10^9 kWh are available in the chimney, and over 10^{10} kWh in the central portion of the fracture zone. Using the current commercial value of 2 mills/kWh for such steam, the above heat has a worth of over $30,000,000. In addition, heat flow into the fracture zone would represent over $1 million per year additional value. Interconnection of fractures drawing heat from far removed volumes would be very site-dependent and difficult to estimate, and have not been included. Use of an array would permit circulation between chimneys with the resultant utilization of the heat energy contained in the intervening volume. Ground shock associated with such an application would probably require development of a 30 to 50 year supply before the power plant is constructed. Radiological safety problems would be confined to operation of the power plant. (auth)

41543 (CONF-700101–(Vol.2), pp 1386-1405) DIMENSIONAL ANALYSIS FOR THE MECHANICAL EFFECTS OF SOME UNDERGROUND EXPLOSIONS. Delort, Francis (Commissariat a l'Energie Atomique, Bruyeres-le-chatel (France). Centre d'Etudes).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The influence of the medium properties upon the effects of underground nuclear and high explosive explosions is studied by dimensional analysis methods. A comparison is made with the experimental data from the Hoggar contained nuclear shots, specially with the particle motion data and cavity radii. Furthermore, for example, crater data from explosions in Nevada have been examined by statistical methods. (auth)

41544 (CONF-700101–(Vol.2), pp 1406-27) STUDY OF THE MINERALOGICAL TRANSFORMATIONS OF GRANITE BY UNDERGROUND NUCLEAR EXPLOSIONS. Faure, Jean (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

New data about the petrographic effects of the underground nuclear explosions are presented, based on the results of French tests in granite rock. The samples were collected by drilling and the temperature of the rock was measured in the hole. Four types of melted rocks were sorted, grey-green glass and pumices, beige to red-brown pumices, dark lavas, dark veinlets and crushed granite. The distribution of these rocks is studied. Optical microscopy, x-rays and chemical analysis, and study by electron probe were used. The results complete previously published data, and are of interest as far as the use of nuclear explosions for industrial applications is concerned. (auth)

41545 (CONF-700101–(Vol.2), pp 1428-55) SUBSIDENCE CAUSED BY AN UNDERGROUND NUCLEAR EXPLOSION. Hakala, W. W. (Environmental Research Corp., Alexandria, Va.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

An underground nuclear detonation creates a cavity, which may be followed by the formation of a rubble chimney and possibly by a surface subsidence crater. A knowledge of the mechanisms of surface and subsurface subsidence is valuable not only because of the potential engineering uses of the chimneys and craters that may form, but also for the prevention of surface damage. Some of the parameters that are of interest in the subsidence phenomenon are the height and volume of the chimney, the porosity of the chimney, the crater size (depth and radius) and shape, and the time required after detonation for formation of the chimney or crater. The influence of the properties of the subsidence medium on the geometry of the subsidence crater must be considered. The conditions under which partial or complete subsidence is prevented must also be studied. The applicability of the relations that have been developed for the flow of bulk solids for relatively small masses and low pressures to the subsidence problem associated with nuclear explosions is examined. Rational modifications are made to describe the subsidence problem. Sensitivity of the subsidence parameters to material properties and the prevailing geometry is shown. Comparison with observed results at the Nevada Test Site is made and the variations encountered are found to be within reasonable limits. The chimney size and subsidence crater dimensions are found to be a function of the bulking characteristics of the medium, the strength parameters, the dimensions of the subsurface cavity, and the depth of the cavity. The great influence of the strength parameters on the collapse times is shown. For a given medium, the prevention of subsidence is dependent on the cavity size. (auth)

41546 (CONF-700101–(Vol.2), pp 1456-73) SIMULATION OF THE CHEMICAL ENVIRONMENT OF A NUCLEAR EXPLOSION WITH EXPLODING WIRES. Meyer, Walter; Block, Oliver U. J. (Kansas State Univ., Manhattan).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The chemical processes in an expanding underground cavity resulting from a nuclear explosion cannot be predicted or controlled as well as such physical characteristics as crater size, magnitude of the outgoing shock wave, or the extent of rock fracturing. However in most underground nuclear explosions it would be desirable to control the chemical and/or physical form and amount of radioactive fallout venting from the explosion. The high temperatures and corresponding high energy densities produced by exploding wires are sufficient to produce in the wire and material immediately surrounding it the temperature (a few thousand degrees) required to simulate the chemical environment of a nuclear explosion in the time interval just preceding the venting of the cavity. The economics and the size of exploding wire apparatus make this type of experiment readily applicable to laboratory study. Design of exploding wire circuits to obtain particular temperatures or energy densities can be completed using several different combinations of circuit and wire conditions. Since the circuit parameters, including charging voltage, capacitor bank capacitance and circuit inductance primarily determine the cost of the necessary laboratory equipment, these parameters should be selected by theoretical expressions while also considering economic factors. Wire parameters are then experimentally determined to produce the most energetic explosions with the selected circuit parameters. A theoretical method applicable to designing exploding wire circuits to produce the desired high temperatures and energy densities in the wire and surrounding sample material was obtained. The method assumes that a thermal spike of energy is deposited in a low conductivity material (typical of the earth's crust) surrounding the wire. From the assumed temperature distribution in the surrounding sample material the energy which must be deposited in the thermal spike to produce the desired temperature and energy density in a fixed amount of sample material can be calculated. The wire temperature corresponding to this energy is then calculated. Assuming the maximum input power to the wire resistance (which is much greater than the resistance of the rest of the RLC circuit) is balanced by radiation energy losses from the wire, an estimate of the maximum temperature reached by the wire can also be obtained. Experimental data show that about fifteen to forty percent of the energy initially stored in a capacitor bank is deposited in the wire before the wire bursts in the energetic type explosion needed to simulate the chemical environment of a nuclear explosion. Further, the experimental results show that if sufficient energy is available from the capacitor bank to satisfy the above efficiency constraint on energy transfer, then the circuit designed by the theoretical design method produces temperatures in the sample material within at least an order of magnitude of the design temperature. Experimental results with bare wire explosions show that confining the wire after sufficient energy to vaporize the

wire has been deposited will produce higher energy densities. A sample cell designed to make use of the magnetic pinch principle has been assembled and experimental results with it show that the cell does indeed confine the wire material while holding the sample material in close proximity around the wire. (auth)

41547 (CONF-700101–(Vol.2), pp 1474-84) POSSIBLE HAZARD REDUCTION BY USING DISTRIBUTED PHASED NUCLEAR EXPLOSIONS. Chilton, Frank (Stanford Research Inst., Menlo Park, Calif. California Univ., Davis. Dept. of Applied Science); Cheney, James A. (California Univ., Davis. Dept. of Civil Engineering).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The use of two or more nuclear devices, phased together in order to constructively add their respective particle velocities, is proposed herein. By directing the seismic waves of the nuclear explosions to make them more efficient in accomplishing the intended construction, we hope to be able to reduce the radioactivity, seismic, and airblast hazards substantially. Experiments are being performed with one gram charges of PETN. (auth)

41548 (CONF-700101–(Vol.2), pp 1485-1507) REVIEW: AIRBLAST EFFECTS. Reed, Jack W. (Sandia Labs., Albuquerque, N. Mex.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The effects of geologic and meteorologic conditions on the propagation of air blasts from underground nuclear explosions were studied and correlated with test data from Project Plowshare explosions. Methods for predicting the damage to glass and structures due to air blast are discussed. (L.C.L.)

41549 (CONF-700101–(Vol.2), pp 1508-43) CLOSE-IN AIRBLAST FROM UNDERGROUND EXPLOSIONS. Vortman, L. J. (Sandia Labs., Albuquerque, N. Mex.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Air overpressures as a function of time have been measured from surface zero to about 170 ft/lb$^{\frac{1}{3}}$ along the ground from nuclear and chemical explosions. Charge depths varied from the surface to depths below which explosion gases are contained. A ground-shock-induced air pressure pulse is clearly distinguishable from the pulse caused by venting gases. Measured peak over-pressures show reasonable agreement with the theoretical predictions. In a given medium the suppression of blast with explosion burial depth is a function of the relative distance at which the blast is observed. Rates of suppression of peak over-pressure with charge burial are different for the two pulses. Rates are determined for each pulse over the range of distances at which measurements have been made of air overpressure from chemical explosions in several media. Nuclear data are available from too few shots for similar dependence on burial depth and distance to be developed, but it is clear that the gas venting peak overpressure from nuclear explosions is much more dependent on medium than that from chemical explosions. For above-ground explosions, experiment has shown that airblast from a 1-kiloton nuclear explosion is equal to that from a 0.5-kiloton TNT explosion. Data on ground-shock-induced airblast is now sufficient to show that a similar relationship may exist for buried explosions. Because of medium dependence of the gas venting pulse from nuclear explosions, data from additional nuclear events will be required before a chemical/nuclear airblast equivalence can be determined for the gas-venting pulse. (auth)

41550 (CONF-700101–(Vol.2), pp 1544-62) PREDICTION OF GAMMA EXPOSURE RATES IN LARGE NUCLEAR CRATERS. Tami, Thomas M.; Day, Walter C. (Army Engineer Nuclear Cratering Group, Livermore, Calif.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The mathematical model to predict the crater and lip exposure rate in large nuclear craters is based on calculating the exposure rate above an infinite slab source with a uniform source density. This configuration was shown to be applicable in the crater and lip area. The source was divided into two groups: the radionuclides from neutron activation, and the fission products. The model was applied to several past nuclear cratering events and a normalization factor found which depends on the event's scaled depth of burst. The time dependence of the exposure rate was determined by considering only radioactive decay. Finally, conservative estimates of the exposure rate as a function of time after the detonation were given for five nuclear explosive yields. The calculated exposure rate for the Schooner event, fitted to the experimental values of the exposure rate, certainly demonstrates that the model has the capability to predict accurately. Documentation of the exposure rate in and around future nuclear craters will provide a means of testing this model and should increase the model's reliability. An important aspect of the model is that it can be used for craters produced with any nuclear device. Only predetonation estimates of the radionuclides produced by the detonated device are required. However, since an approximation was made for the exposure rate from fission products, the model should predict more accurately as the ratio of the fission yield to the total yield of a device decreases. The scaled depth of burst of an event is the most important factor in determining what the resulting exposure rate will be. Estimates show that for large yield Plowshare cratering events, at a constant scaled depth of burst, that the exposure rate will decrease with increasing yield. (auth)

41551 (CONF-700101–(Vol.2), pp 1563-8) REDUCTION OF RADIOACTIVITY PRODUCED BY NUCLEAR EXPLOSIVES. Lessler, Richard M. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Four main sources contribute to the radioactivity produced by a nuclear explosive: fission products from the nuclear explosive; fusion products from the nuclear explosive; induced radioactivity in the nuclear explosive; and induced radioactivity in the environment. Some of the work done at the Lawrence Radiation Laboratory to reduce the radioactivity from these sources to levels acceptable for peaceful applications is summarized. An example is given of how, between 1962 and 1967, the radioactivity released from a 100 kt explosive has been reduced from that equivalent to 2000 tons of fission to the equivalent release from 60 tons of fission. It is concluded that considerable progress has been made in reducing radioactivity from a nuclear explosive, and that continuing progress is anticipated. (L.C.L.)

41552 (CONF-700101–(Vol.2), pp 1569-88) RADIOACTIVE CONTAMINATION OF COPPER PRODUCED USING NUCLEAR EXPLOSIVES. Crouse, D. J.; Arnold, W. D.; Hurst, F. J. (Oak Ridge National Lab., Tenn.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Laboratory tests simulating the processing of copper ore after fracturing with nuclear explosives indicate that only very small fractions of the radioactive fission products will be dissolved on leaching with dilute sulfuric acid. Tritium (as tritiated water) will be by far the dominant radionuclide in the circulating leach liquor, assuming use of a fusion device. Only ^{106}Ru appears of significant importance with respect to contamination of the cement copper. It is rejected effectively in electrolytic purification and, therefore, the final copper product should be very low in radiocontamination and not hazardous to the customer. The activity level may be high enough, however, to make the copper unsuitable for some specific uses. If necessary, solvent extraction can be used as an alternative to the cementation process to reduce the radioactivity of the copper products. The tritium in the circulating liquor and the ^{106}Ru in the cement copper are potential hazards at the plant site and must be given consideration in designing and operating the facility. However since the activity levels will be low, the protection necessary to ensure safety of the operating personnel should be neither difficult nor costly to provide. (auth)

41553 (CONF-700101–(Vol.2), pp 1597-1612) RADIOACTIVE CONTAMINATION OF OIL PRODUCED FROM NUCLEAR-BROKEN SHALE. Arnold, W. D.; Crouse, D. J. (Oak Ridge National Lab., Tenn.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

The results of small-scale exposure and retorting tests indicate that oil recovered from shale that has been broken with nuclear explosives will be contaminated with tritium. When oil shale was heated in sealed flasks with tritiated water vapor or with tritiated hydrogen, both the shale and the oil subsequently retorted from the shale contained tritium. There was much less contamination of the shale or oil, however, when the shale was exposed to tritiated methane and ethane. Contamination of shale and oil with tritium, as the result of exposure to tritiated water, increased as the exposure temperature, exposure pressure, and the tritium concentration in the water were increased. This contamination also increased as the exposure time was increased up to 25 days, but not significantly thereafter. More than 90% of the tritium was removed from contaminated shale by treating the shale with moist air at elevated temperatures. Only small amounts of the tritium were removed from crude oil by contacting it with solid drying agents or with water. When tritium-contaminated shale oil was distilled, the tritium contents of the recovered fractions were found to be approximately equal. After being heated with a sample of underground test-shot debris, liquid shale oil became contami-

nated with radioactive fission products. Most of the radioactivity of the oil was due to finely dispersed solids rather than to dissolved radionuclides. Filtration of the oil removed a major fraction of the radioactive material. When the contaminated oil was distilled, more than 99% of the radionuclides remained in the pot residue. (auth)

41554 (CONF-700101-(Vol.2), pp 1613-42) EJECTA FROM SINGLE-CHARGE CRATERING EXPLOSIONS. Carlson, R. H. (Boeing Co., Seattle, Wash.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

Experimental data were obtained for tracing the location of ejecta to its origin within the crater region. The experiment included ten high-explosive spherical charges weighing from 8 to 1000 pounds and detonated in a playa dry lake soil on the Tonopah Test Range. Each event included from 24 to 40 locations of distinctly different tracer material embedded in a plane in the expected crater region. Tracers consisted of glass, ceramic and bugle beads, chopped metal, and plastic wire. Results of this experiment yielded data on tracer dispersion as a function of charge weight, charge burial depth and tracer emplacement position. Tracer pattern parameters such as center-of-tracer mass, range to center-of-tracer mass, and angle to center-of-tracer mass were determined. There is a clear tendency for range (to center-of-tracer mass) and the size of the dispersion pattern to decrease as tracer emplacement depth increases. Increasing tracer emplacement depth and range tends to decrease the area over which tracers are dispersed on the ground surface. Tracers at the same scaled position relative to the charge were deposited closer to the crater (on a scaled basis) as charge weight was increased. (auth)

41555 (CONF-700101-(Vol.2), pp 1643-60) AN INTERIOR SEAWAY FOR NORTHERN AFRICA. Champlin, J. B. F. (Westinghouse Electric Corp., Pittsburgh, Pa.); Poston, J. W.; Lake, J. A. (Georgia Inst. of Tech., Atlanta).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

A student project is presented which examined the feasibility of using nuclear explosives to create an interior seaway which would connect the Chott region in central Tunisia and Algeria to the Mediterranean Sea. The factors discussed include the physiography of the area, environmental conditions, emplacement of the explosives, the expected cratering results, post-shot earth moving requirements, and estimated cost of the project. It is concluded that nuclear excavation of such a canal is economically and technically feasible. (L.C.L.)

41556 (CONF-700101-(Vol.2), pp 1661-1678) STABILITY OF NUCLEAR CRATER SLOPES IN ROCK. Fleming, Robert W.; Frandsen, Alton D.; LaFrenz, Robert L. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

The engineering properties of craters were studied in a research program to develop nuclear engineering and construction technology. The research included investigations of crater properties in various media over a broad range of chemical and nuclear explosive yields, studies of man-made and natural slopes, and the development of analytical and empirical methods of crater stability analysis. The stability of nuclear craters is of particular interest to feasibility studies of a proposed nuclearly-excavated Atlantic-Pacific sea-level canal. A general understanding was developed of the effects of a cratering explosion on the surrounding medium and of the physical nature of the various crater zones which are produced. It was concluded that assessment of crater slope stability in rock requires specific information on crater geometry, geologic conditions and rock properties at the site, seepage and weathering characteristics of the materials, and that certain general characteristics of craters and crater slopes make them inherently stable. A sample empirical stability analysis for planned slopes along an interoceanic canal route is provided to illustrate the types of information assembled and the way it is used. (L.C.L.)

41557 (CONF-700101-(Vol.2), pp 1679-91) CONCEPT OF ROW CRATER ENHANCEMENT. Redpath, B. B. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

An analytical procedure is developed for designing a detonation program for using row charges to excavate a linear crater with a specified configuration. Preliminary results of row cratering tests, particularly Pre-Gondola III Phase III cratering data, are presented. Results of the tests indicate that the concepts relating to enhancement and charge spacing are essentially correct, that enhancement varies inversely as the square roots of the charge spacing provided that the depth of burst is increased correspondingly, and that the efficiency of a row charge in excavating shale appears to be about 30% greater than for a series of single charges. Although this concept of enhancement has been used in feasibility studies of nuclear excavation projects, it is anticipated that it will find its widest application in excavation projects with chemical explosives where emplacement costs can be reduced by employing smaller charges. (L.C.L.)

41558 (CONF-700101-(Vol.2), pp 1692-1700) TORRES STRAIT: A CHANNEL CLEARING PROJECT. Bankert, Stanley (California Univ., Davis. Dept. of Applied Science).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

The possibility of using nuclear explosives to create a safe shipping channel through the Torres Strait between New Guinea and Australia was investigated. The topography and geology of the region, which is adjacent to the Great Barrier Reef area, are discussed. Assuming that the channel would be 180 miles long, 1000 ft wide, and about 250 ft deep, the quantity and size of explosives required and the cost of the project are estimated. It is concluded that this channel excavation is technically and probably economically feasible, but that the effects of this construction on the environment of the Great Barrier Reef remain to be evaluated. (L.C.L.)

41559 (CONF-700101-(Vol.2), pp 1701-25) STUDY OF UNDERGROUND EXPLOSION CRATERING PHENOMENA IN DESERT ALLUVIUM. Saxe, H. C.; DelManzo, D. D. Jr. (Louisville Univ., Ky. Speed Scientific School).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

An analysis of the complete series of high explosive and nuclear cratering tests performed primarily in desert alluvium located at the Nevada Test Site is presented. It is felt that the dimensionless parameter referred to as the throwout ratio and depth ratio provides investigators with a very simple method of crater prediction. The linear relationships developed can furnish further insight into the mechanism of cratering, and provide a capability for scaling from HE to nuclear events not only for a particular radius or depth, but also for shape, i.e., maintenance of a specified radius to depth ratio. (auth)

41560 (CONF-700101-(Vol.2), pp 1726-45) SIMPLE TECHNIQUE TO DETERMINE THE SIZE DISTRIBUTION OF NUCLEAR CRATER FALLBACK AND EJECTA. Anderson II, Brooks D. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

The results of an investigation to find an economic method for determining the block size distribution of nuclear crater fallback and ejecta are described. It is shown that the modal analysis method of determining relative proportions can be applied with the use of a special sampling technique, to provide a size distribution curve for clastic materials similar to one obtainable by sieving and weighing the same materials. (auth)

41561 (CONF-700101-(Vol.2), pp 1746-70) SCHOONER EJECTA STUDIES. Henny, Robert W. (New Mexico Univ., Albuquerque).

From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.

A preliminary analysis of the Schooner ejecta and missile population is presented. The Schooner Event results were studied to further the understanding of cratering phenomenology with emphasis directed toward the development of photographic techniques for documentation of the static and dynamic aspects of large ejecta and missile populations. The results are presented graphically and show the vertical and horizontal distribution of ejecta, size distribution of ejecta particles, and the location of various size ejecta particles relative to ground zero. (L.C.L.)

41562 (NVO-289-6) OCEAN SURFACE EFFECTS GENERATED BY A NEARBY UNDERGROUND EXPLOSION AT THE AMCHITKA TEST. FINAL REPORT. Report TC-174-1. Koh, R. C. Y.; Rosencrantz, D. (Tetra Tech, Inc., Pasadena, Calif.). 20 Apr 1970. Contract AT(26-1)-289. 39p. Dep. CFSTI.

An investigation was made of the patches of whitewater that appeared in the nearshore waters off Amchitka Island following the Milrow Event. Individual frames were selected from the motion picture coverage and analyzed. The spatial distributions of the patches were mapped from the photographs. The results are shown in figures. The hypothesis advanced to explain the formation of white water and its patchiness is that the white water is due to cavitation bubbles formed in the water as a result of shockwave passage. Because of the relatively long pres-

sure rise time when compared with the propagation time in the water layer, it is found that the generation of negative pressures in the water layer is sensitive to the local depth. This implies that the patchiness of the white water should be correlated with the bathymetry of the nearshore area. This is supported by the figures. (auth)

41563 (PNE-203-F) THE SEDAN EVENT. On-Site Radiological Safety Report. (Reynolds Electrical and Engineering Co., Inc., Mercury, Nev. Radiological Safety Div.). 23 Oct 1962. Contract AT(29-2)-162. 62p. Dep. CFSTI.

The on-site radiological support program for Project Sedan was established to assist in exclusion area control, to minimize the radiation exposure of participating personnel and observers, and to prevent the spread of radioactive contamination. The support program included all phases of radiation safety. Initial radiological data were obtained by hard-wire telemetry readout at the CP-2 Rad-Safe facility. At H + 1 hours, when dust conditions subsided to a point of acceptable visibility, the initial survey began. Party monitors entered the area and reported dose rates at pre-selected locations. These measurements were obtained using hand carried instruments. Measurements indicated that significant radioactive fallout from the nuclear explosion was deposited in an oval pattern around ground zero and contained within the boundaries of the Test Site. At H + 2 hours, a complete definition of the area of significant fallout was easily discernible. The 1,000 and 10,000 mr/hr contours assumed a distinct oval shape. The diameter of the 1,000 mr/hr isodose rate contour was approximately 4.5 miles, and the diameter of the 10,000 isodose rate contour was approximately 2.25 miles. (auth)

41564 (PNE-R-31) PROJECT RULISON. CER GEONUCLEAR CORPORATION'S PARTICIPATION IN THE SAFETY PROGRAM. (Austral Oil Co., Inc., Houston, Tex. CER Geonuclear Corp., Las Vegas, Nev.). 28 Jul 1970. Contract AT-(26-1)-429. 23p. Dep. CFSTI.

CER Geonuclear was responsible for the mine and quarry evacuation program, the census, medical survey and shot-time building evacuation of the communities of Grand Valley and Rulison, and the turning off and on of the service utilities to all houses within the five-mile radius of the Rulison SGZ. A total of 24 mines and quarries were evacuated or were determined to be inactive at detonation time out to a radius of 43 miles from SGZ. All of the buildings within the communities of Grand Valley and Rulison were evacuated without incident with the help of the Garfield County Sheriff's posse. To further minimize the remote possibility of fire if gas lines or electrical wiring were damaged by the Rulison ground motion, service utilities to 42 homes were turned off prior to the event. After the event, the service systems were checked for damage, repaired where necessary, and service restored. Damage was minimal and somewhat questionable as to being event-caused. (auth)

Facilities and Equipment

Refer also to abstracts 41440, 41518, 42117, 42206, 42223, 42609, and 42627.

41565 (DP-Report-148) THE DEVELOPMENT OF THE PLASMA ARC FURNACE FOR FUEL MELTING. Project DRAGON. Jaques, T. A. J.; Sturge, D. W. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 18p. (CONF-630103-16). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

The furnace was developed to melt UZrC and $(U,Th)C_2$ fuel particles. The melting vessel, including the plasma generator, is 48 inches long and 6 inches internal diameter. The maximum particle output is 200 grams per hour. (J.R.P.)

41566 (DP-Report-163) BEARINGS AND GEARS FOR OPERATION IN INERT GASES. Project DRAGON. Fricker, H. W. (Atomic Energy Establishment, Winfrith (England)). Mar 1963. 40p. (CONF-630512-1). Dep. CFSTI.

From Meeting of the Institution of Mechanical Engineers, Bournemouth, Eng.

A program of tests on plain bearings, roller bearings, and gears is described, the object of which was to determine if any commercially available components would operate satisfactorily in the very pure helium coolant of the Dragon reactor at high temperature. Of the dry bearings, tool steel and MoS_2 lubricated EN31 ball bearings were satisfactory. Tests on greased bearings showed that APL701 and Nucleol G121 lubricated bearings would be satisfactory for the charge-discharge machine but not for bearings operating continuously at over 150°C. Gears made from nitrided steel, vapor- or sand-blasted and treated with MoS_2 successfully carried loads of up to 20% of their capacity under fully lubricated conditions. Grease lubrication reduced the friction losses but lasted only 150 hours at 150°C. (auth)

41567 (DP-Report-256) THE DRAGON HIGH TEMPERATURE MULTI-PURPOSE LABORATORY FURNACE. Project DRAGON. Hansen, R. (Atomic Energy Establishment, Winfrith (England)). Feb 1964. 25p. Dep. CFSTI.

The design features of a furnace for developing high temperature techniques and experiments carried out in it are described. The furnace is capable of heating samples by induction, electron beams, and resistance heating, making use of any kind of heating element with a power requirement less than 60 kW. (auth)

41568 (DP-Report-259) DETERMINATION OF THE OPTIMUM COMBINATION OF VALVE COMPONENT GEOMETRY AND MATERIALS. Project DRAGON. Nullens, G. C.; Day, M.; Woodley, H. J. (Atomic Energy Establishment, Winfrith (England)). Mar 1964. 52p. Dep. CFSTI.

In order to assess the best valve design and choice of materials for a valve working in pure helium gas at a temperature up to 350°C, an extensive series of tests were performed. By varying the valve seat and plug geometry and the materials from which they were made, it was possible to optimize these parameters. Emphasis was placed on letting the valve plug center itself freely on the seat to reduce rubbing between the sealing surfaces to an absolute minimum. Results indicated that if the plug material was harder than the seat material, the combination 90° plug/sharp angle seat was the most promising. (auth)

41569 (DP-Report-281) THE DRAGON DUMMY FUEL ELEMENTS. Project DRAGON. Smith, E. (Atomic Energy Establishment, Winfrith (England)). Jun 1964. 29p. Dep. CFSTI.

The design of the two forms of dummy fuel elements used in the Dragon Reactor are described. The limitations of the designs are discussed and it is shown that for their projected use no serious operational restrictions exist. It is, however, concluded that dummy elements should not be left in the core during full temperature or power operation of the reactor. (auth)

41570 (DP-Report-305) TESTS ON SOLENOID OPERATED VALVES FOR LEAK DETECTION AND GAS SAMPLING SYSTEMS. Project DRAGON. Woodley, H. J. (Atomic Energy Establishment, Winfrith (England)). Dec 1964. 24p. Dep. CFSTI.

Following a series of unsuccessful tests on a type of valve originally intended for the leak detection system, tests yielding acceptable results at room temperature were made on a modified design. The valve designed for the gas sampling system was also unsuccessful in its original form but slight modification gave acceptable results over the lower working temperature range. Results so far obtained at high temperature have not been encouraging, but further long term tests are continuing. (auth)

41571 (DP-Report-306(Pt.1)) EXPERIMENTAL STUDY OF TILTING PAD GAS BEARINGS. PART 1. RADIAL PADS. Project DRAGON. Mech, C.; Poulain, J.; Fricker, H. W. (Societe Rateau, La Courneuve (France)). Dec 1964. Contract CON/WIN/51074. 78p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

An experimental investigation into the behavior of gas-lubricated single radial pads was carried out on special test equipment. A radial pad consists of a segment of a cylindrical shell, pivoted in one point, in which the shaft is running. The influence on gas film thickness and shape of the parameters load, speed, size, clearance, and pivot location was studied. (auth)

41572 (DP-Report-306(Pt.2)) EXPERIMENTAL STUDY OF TILTING PAD GAS BEARINGS. PART 2. AXIAL PADS. Project DRAGON. Mech, C.; Fricker, H. W. (Societe Rateau, La Courneuve (France)). Dec 1964. Contract CON/WIN/51074. 56p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

An experimental investigation into the behaviour of single, gas lubricated, axial pads was carried out using special test equipment. The test pad consisted of an annular sector running against the axial face of a rotor. Both running surfaces were plane. The influence of load, speed, and pivot location on gas film thickness was studied and the results compared with various lubrication theories. (auth)

41573 (DP-Report-344) STRESS CONCENTRATIONS AROUND UNREINFORCED CIRCULAR HOLES IN A PLATE UNDER UNIDIRECTIONAL STRESS. Project DRAGON. Kinkead, A. N. (Atomic Energy Establishment, Winfrith (England)). May 1965. 27p. Dep. CFSTI.

An approximate method of analysis of the stress concentrations and strain conditions around unreinforced circular holes in a plate

under unidirectional stress is described. The perforated plate problem under either unidirectional or hydrostatic plane stress loading conditions is examined by an analogy, believed to be original. The method differs from previous classical mathematical approaches in that it avoids the complexity of bi-polar coordinates and is used instead to study the strain conditions at a finite boundary circumscribed around each opening. The results are given in the form of simple equations and some values of the more important parameters have been graphed. These results appear to correlate with previous mathematical solutions for the most important and highly stressed region. The method is directly applicable to more complex situations than the one described and to problems which cannot readily be solved by rigorous mathematics. (auth)

41574 (DP-Report-386) BEARING TESTS: A SUMMARY OF WORK DONE UP TO DECEMBER 1964. Project DRAGON. Fricker, H. W. (Atomic Energy Establishment, Winfrith (England)). Nov 1965. 46p. Dep. CFSTI.

Details are given of the results of nearly five years of work on plain and ball bearings. Most of the tests were carried out under arduous conditions of high temperature and oxygen-free atmosphere. Various conditions of lubrication were investigated, ranging from none at all to the application of special greases. In some experiments the rubbing conditions encountered in gear teeth were simulated while in others the object was to investigate the feasibility of dispensing with jacking gas when starting and stopping machinery carried on hydrodynamic gas bearings. (auth)

41575 (LIB/Trans-281) NEW PLANTS FOR THE PRODUCTION OF UO_2 POWDER FROM UF_6. Hackstein, K. G.; Ploeger, F. Translated by J. B. Hopkinson (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Atomwirt., Atomtech.; 12: 524-6(Nov 1967). 6p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 22: 12490. (Australia)

41576 (MSAR-69-151) MOISTURE SEPARATOR DEVELOPMENT. Quarterly Progress Report, April-June 1969. (MSA Research Corp., Evans City, Pa.). Aug 1969. 4p. Dep. CFSTI.

Efforts during the period were devoted to a literature search on moisture separators, product surveys, and planning for tests. Preliminary work is also reported on development of liquid drop measuring techniques. (J.R.D.)

41577 (MSAR-69-192) MOISTURE SEPARATOR DEVELOPMENT. Quarterly Progress Report, July-September 1969. (MSA Research Corp., Evans City, Pa.). Oct 1969. 7p. Dep. CFSTI.

Work during the period was devoted to analysis of information obtained in a literature survey on moisture separators, product surveys, test plan formulation, development of drop size measuring techniques, and development of drop size separation methods. (J.R.D.)

41578 (MSAR-70-17) MOISTURE SEPARATOR DEVELOPMENT. Quarterly Progress Report, October-December 1969. (MSA Research Corp., Evans City, Pa.). Jan 1970. 5p. Dep. CFSTI.

Efforts during the period were devoted to information collection, evaluation, and preliminary testing. Developmental work is reported on droplet measurement techniques, aerosol generator development, and development of moisture separator prototypes. (J.R.D.)

41579 (MSAR-70-79) MOISTURE SEPARATOR DEVELOPMENT PROGRAM. Quarterly Progress Report, January-March 1970. (MSA Research Corp., Evans City, Pa.). Apr 1970. Contract AT(45-1)-2145. 4p. Dep. CFSTI.

Work during the period included evaluation of commercially available moisture separators, design and construction of prototype separators, and completion of literature surveys on moisture separators. (J.R.D.)

41580 (NP-9743) ON THE POSSIBILITY OF REMOVING HYDROGEN FROM THE DRAGON COOLANT BY DIFFUSION THROUGH A PALLADIUM MEMBRANE. Project DRAGON. Horsley, G. W. (Atomic Energy Establishment, Winfrith (England)). Nov 1960. 13p. (DP-Report-7). Dep. CFSTI.

To remove the hydrogen impurity in the Dragon coolant, estimates have been made of the extraction rate of this gas through a 1000 cm^2 palladium membrane sited in the coolant clean-up circuit and operating at 350°C. They suggest that provided the pressure of hydrogen on the extraction side of the membrane is negligible compared with that in the coolant, it should be possible using 10 and 2 mil-thick membranes to reduce the concentration of hydrogen in Dragon from 10,000 to 100 vpM in about 14 and 4 days respectively. (auth)

41581 (NP-10129) LEAK TESTING OF THE TEST VESSEL AND EXPERIMENTAL GASKETS AT MANNESMANN, HUCKINGEN, WEST GERMANY. PART I. Project DRAGON. Barnes, D.; Wade, F. (Atomic Energy Establishment, Winfrith (England)). Apr 1961. 17p. (DP-Report-23). Dep. CFSTI.

The results of pressure vessel tests carried out at Mannesmann, West Germany during the period November 16, 1960 to December 18, 1960 are reported. The full program will take several months to complete and reports will be made at suitable intervals to give information of the results obtained. (auth)

41582 (NP-10871) THE SELECTION OF GREASES FOR THE LUBRICATION OF BEARINGS IN THE DRAGON REACTOR. Project DRAGON. Horsley, G. W.; Fricker, H. (Atomic Energy Establishment, Winfrith (England)). Sep 1961. 22p. (DP-Report-51). Dep. CFSTI.

To select a suitable lubricant for the bearings in the Dragon charge machine a number of commercially available greases were examined by evaporation and ball bearing tests. As a result of these tests only the Shell product A.P.L. 701 can be recommended. Moreover this grease should be an effective lubricant for bearings for the lifetime of the reactor (20 years) provided that grease losses by mechanical causes can be avoided. (auth)

41583 (NYO-3979-4) ADVANCED HEAT PIPE THERMIONIC TECHNOLOGY. TOPICAL REPORT, TASK II. DEVELOPMENT OF ADSORPTION RESERVOIR. Period of Performance, March 1, 1969-September 30, 1969. Freggens, R. A. (RCA Corp., Lancaster, Pa.). Contract AT(30-1)-3979. 48p. Dep. CFSTI.

Work performed on the development of an integral adsorption reservoir thermionic converter is described. Three general areas were investigated during the study including cesium purification, material processing, and integral reservoir converter fabrication. The cesium purification employed a high temperature reaction to remove halide compounds. A study was also made to develop a large surface to volume ratio in a molybdenum matrix. Variations in time, temperature, and atmosphere for sintering the matrix were used as the basis of the study. The RCA A-1279 Thermionic Converter was modified to include an integral matrix reservoir and designated the RCA A-1345. The modified design included 80 cm^3 of reservoir matrix integrally located within the converter. The device was fabricated, processed, and electrically life tested using its own internal cesium reservoir for a period of 380 hours before the heat pipe-heat source failed forcing termination of the test. Long term changes in electrical output were observed after installation of each new heat source which confirmed the slowly changing nature of internal cesium equilibrium. The ability of the converter to operate successfully and stabilize at a new satisfactory level of performance after each thermal cycle validates the fundamental design. (auth)

41584 IMPROVEMENTS IN AND RELATING TO FLUID OPERATED ROTARY DEVICES. Berthaud, Jean (to Commissariat a l'Energie Atomique). British Patent 1,197,683. 8 Jul 1970. Priority date 21 Jul 1967, France.

A fluid operated rotary device for controlling rotary plug valves is described. It is designed to operate quarter-turn type valves in which the change-over of the valve plug from the open to closed position or conversely is effected as a result of the rotation of a rod or control lever through an angle of approximately 90°. (J.R.D.)

41585 NEW GAMMA IRRADIATION PLANT AT KJELLER: CONSTRUCTION AND APPLICATION. Been, Ulf (Institutt for Atomenergi, Kjeller, Norway). Fra Fys. Verden, No. 3: 49-56(1969). (In Norwegian).

The conversion of the biological shield of the former JEEP reactor to a gamma irradiation plant is described. The gamma source will be initially 10,000 to 20,000 Ci ^{60}Co with a possible future increase to 100,000 Ci. The projected applications in research and production are described. (Norway)

41586 COMBINED PLUG AND NEEDLE VALVE. Moulin, Gerard (to Commissariat a l'Energie Atomique). British Patent 1,197,240. 1 Jul 1970. Priority date 13 Oct 1967, France.

A small combined plug and needle valve is described that can be fitted to a tubular element to measure its free volume, such as a fuel element or pencil filled with UO_2 pastilles. The combined plug and valve comprises a plug member hermetically sealed to the end of the tubular element and a screw and needle valve attached to the plug. A hood is releasable but hermetically sealed to the plug and bounds a chamber that is disposed above the screw and into which a pipe opens to connect the chamber to the outside. A member is provided to drive the screw and to

open the needle valve. Ducts are provided through the screw and its driving member so that when the needle valve is in the open position, a continuous communication is provided between the pipe through the hood and the inside of the tubular element. (B.L.M.)

41587 ASYMMETRIC BENDING OF CYLINDRICAL CONICAL SHELL JUNCTION. Alwar, R. S.; Ramamurti, V. (Indian Inst. of Tech., Madras). Nucl. Eng. Design; 12: 97-121(May 1970).

The problem of unsymmetric bending of cylindrical conical shell junction has been analyzed. In the method presented the classical assumption of Geckeler's approach has not been made. In the first instance a numerical method has been adopted to solve the shell equations and detailed numerical results have been given for those diameter-to-thickness ratios and angles of discontinuity which are of practical interest. An exact solution has also been worked out in order to indicate how such problems can be tackled by non-numerical methods and the results of this solution have been compared with the results obtained by the numerical method. The effect of the presence of fillet at the cylinder cone junction has also been investigated. (auth)

41588 METHOD OF CONSTRUCTION OF SEALED ENCLOSURES. Bret, Aitoine; Sommeria, Jean (to Commissariat a l'Energie Atomique). British Patent 1,198,565. 15 Jul 1970. Priority date 18 May 1967, France.

A method is described for constructing sealed enclosures, which is particularly applicable to the assembly of nuclear fuel elements by welding. The enclosure comprises a main portion closed at both ends with a cap formed with a large number of ducts of small cross-sectional area, which maintain communication between the interior and exterior of the enclosure when the cap is inserted into the main portion. The entire assembly is then inserted into a leak-tight chamber filled with an inert atmosphere, and the caps are welded in place. (B.L.M.)

41589 IMPROVEMENTS IN AND RELATING TO PUMPING DEVICES. Hasquenoph, Jean; Pouliquin, Marc (to Commissariat a l'Energie Atomique). British Patent 1,196,565. 1 Jul 1970. Priority date 25 Oct 1967, France.

A pumping device, particularly for nuclear use, comprises two pumps, which are relatively disposed so as to be driven by the same rotatable shaft. The first pump comprises a wobble member mounted on the shaft for pivotal movement about the axis of the shaft when the shaft rotates. The wobble member is non-rotatable relative to the pump casing. The second pump comprises an inner cylindrical member mounted on the shaft and an outer cylindrical member. The inner member is eccentrically arranged relative to the outer cylindrical member for circular non-rotational movement relative to the outer cylindrical member. (B.L.M.)

41590 SMALL CENTRIFUGAL EXTRACTOR. Yakovlev, G. N.; Pushlenkov, M. F.; Kuznetsov, G. I.; Shchepetil'nikov, N. N.; Feofanov, A. P. At. Energ. (USSR); 28: 244-5(Mar 1970). (In Russian).

Extractors were developed with working volumes of 150 and 350 cm^3. The bearings were made of stainless steel. The electrical motor driving the extractor could be replaced by remote control. The overall size of the unit was 280 × 280 × 520 mm. The overall throughput was 60 liters/hr. The volumes of the mixing and settling chambers were the same, 50 cm^3. The time of phase contact was 3 seconds. The diameter of the extractor sector was 85 mm. The electric motor had a power of 180 watts and weighed 4.7 kg. The principal material of construction was 18-8 stainless steel. The total weight of the extractor was 34 kg. An equation is given for calculating the boundary position of the two phases in the chamber where the two phases start to form. The extraction efficiency was 97% even after a contact time of only 0.8 seconds. (TTT)

41591 PYCNOMETER MARK VI (Feb 6 1970) (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-2014).

6 drawings.

The vacuum pycnometer measures bulk volume as a step in obtaining bulk density of porous fuel pellets. Measurements are usually made in a hot cell equipped with master-slave manipulators but operation on a lab bench is also possible. The volume measured is the volume bounded by the exposed surface of the sample and the area over cracks and pores. In operation, a plunger of known and uniform cross section is driven by a calibrated screw into a Hg reservoir displacing Hg into an evacuated sealed sample chamber. Pressure is applied to the Hg by driving the plunger into the Hg until a predetermined pressure is sensed by a transducer. The sample chamber is sealed by the specimen chamber seal. A sample volume is determined by the difference in plunger travel between the filling of an empty sample chamber and one with a sample in it multiplied by the cross-section area of the plunger. Volumes up to 2.5 ml are directly measured with an accuracy of better than 0.001 ml and a sensitivity of 0.0001 ml at pressures up to 1000 ml Hg. Effects of the high coefficient of thermal expansion of Hg have been minimized by leaving a large mass of metal around the Hg chamber and by taking a zero measurement before each sample measurement. The minimum measurable plunger movement is 0.0001 cm. The plunger cross section area is 1 cm^2. (For details see TID-4100 Suppl 59) (F.S.)

41592 ELECTRON-BEAM-HEATED CALORIMETRIC SYSTEM (19 Sep 1968) (Engineering Materials). (Argonne National Lab., Ill.). (CAPE-1998).

168 drawings.

The system is used in the determination of high-temperature enthalpies (to 2500°) relative to 25°C. The calorimetric system consists of a furnace that is heated by two remote diametrically opposed electron-beam guns which operates under a high vacuum; a water-cooled shutter located between the furnace and the calorimeter to interrupt radiation from the furnace to the calorimeter; a Cu block calorimeter, the temperature of which is measured by a quartz crystal thermometer; a retractable prism through which optical furnace temperature measurements are made; and a drop mechanism by which it is possible to pneumatically accelerate the sample from the furnace into the calorimeter to minimize heat loss during transfer. Two electron beams are used with the system. During operation, each experiment begins with the temperature of the Cu block below the equilibrium temperature of the water jacket, and ends with the two temperatures as close as possible. This ensures that the largest thermal head exists for the shortest time minimizing the temperature correction. Drop and calibration experiments are performed over the same temperature interval. After the drop, the calorimeter well is filled with 50 torr of He to accelerate heat transfer. A calibration experiment following every drop, and an enthalpy value is determined at a single temperature during one days operation which includes a drop of the empty capsule and a drop of the capsule plus the sample. (F.S.)

41593 METHOD AND APPARATUS UTILIZING A RADIOACTIVE SOURCE AND DETECTOR FOR WEIGHING MATERIAL CARRIED BY A SCREW CONVEYOR. Gruenwald, Clifford L. (to Ohmart Corp.). U. S. Patent 3,518,425. 30 Jun 1970. Filed 17 May 1966.

Apparatus for weighing the amount of material delivered by a screw conveyor is described. The apparatus includes an elongated radioactive source and an elongated detector, such as an ionization chamber, Geiger tube or the like. The source and detector are mounted parallel to one another on opposite sides of the screw conveyor. The axis of the source and detector are disposed substantially perpendicular to the free surface of material carried by the conveyor. The detector generates an electrical signal corresponding to material weight per unit length of conveyor. A tachometer generates a signal corresponding to conveyor speed. These signals are multiplied and integrated to detect a signal corresponding to total material weight. (auth)

41594 SOVIET LMB AND RX GAMMA IRRADIATORS. Kaouchanski, D. A. Energ. Nucl. (Paris); 12: 239-42(May-Jun 1970). (In French).

A description is given of a gamma irradiator (LMB-gamma-1M) using ^{137}Cs and ^{60}Co. The source activity is between 480 and 2,600 curies. Then descriptions of the industrial gamma irradiators RX-gamma-30 and RMX-gamma-20 are given. In both cases, the sources are ^{60}Co with activities of 16,200 and 12,500 curies respectively. The capacity of the irradiation chamber is 4.4 liters; in addition the RMX-gamma-20 irradiation has 6 lateral chambers of 0.7 liters. The various applications of these Soviet irradiators are discussed. (auth) (France)

41595 APPARATUS AND METHOD FOR IRRADIATING CONTINUOUSLY FLOWING LIQUIDS. Brunner, Alfred (to Sulzer Brothers Ltd.). U. S. Patent 3,519,817. 7 Jul 1970. Priority date 16 Mar 1967, Switzerland.

The bulbous elements are periodically introduced into the liquid stream downstream of the radiation field to define individual liquid containing chambers. The liquid in the chambers is mixed in a manner to cause equal residence time of all the liquid particles through the radiation field by the action of the bulbous elements to achieve homogeneous irradiation of all liquid particles. (auth)

41596 CONSTRUCTION OF A ^{60}Co IRRADIATION FACILITY. Heusinger, H.; Gruhn, B. (Munich Technical Univ., Garching, Ger.). Kerntechnik; 12: 229-33(May-Jun 1970). (In German and English).

A ^{60}Co irradiation facility, designed for research work in radiation chemistry and for small scale industrial experiments, is described. The structural design, the shielding, which is

designed for 100 kCi ^{60}Co, and the services installations are described first. Then the dosimetry of the radiation field is discussed, and the safety devices and precautions are described in detail. (auth)

41597 DESIGN AND TESTS OF NULL-BALANCED FISSION GAS PRESSURE TRANSDUCER AND CONTROLLER. Folkrod, John R. (Argonne National Lab., Ill.). Nucl. Appl. Technol.; 8: 432-6(May 1970).

An 0.357 OD null-balanced pressure transducer was designed and built for 900°F at 350 psig service and tested on the bench for seven months at design conditions and 1200 and 1300°F at 350 psig until failure six weeks later. This type transducer was also tested in conjunction with a fuel irradiation experiment in the CP-5 research reactor. It provided experimentors with fission gas pressure readings until failure of the fuel pin. A unique device was used to control the reference gas pressure. Control was obtained by making use of the change in probe-disk electrical contact resistance. This method allowed the transducer to follow increasing and/or decreasing pressures easily and quickly as it took place. Transducers of this type generally operate on the probe making and breaking contact with the disk which makes it easy to follow increasing pressure but becomes difficult to follow decreasing pressures. Resolution of the system was found to be ±1/4 psig with an overall accuracy of ±8 psig for full range. (auth)

41598 ENGINEERING DESIGN OF AN INSTRUMENTED PILOT PLANT FOR REMOTE REACTIONS: RADIATION-INDUCED POLYMERIZATION. Osborne, F. T.; Omi, S.; Stannett, V. T.; Stahel, E. P. (North Carolina State Univ., Raleigh). Nucl. Appl. Technol.; 8: 445-9(May 1970).

A small-scale semi-continuous pilot plant for studying chemical reactions carried out in remote environments is described. The all stainless system features modular construction enabling rapid exchange of various elements. The equipment design permits purification, sampling and other manipulative tasks to be performed in a safe operating area. Dissolved gases and moisture are removed from the reactant mass prior to circulation in the primary reaction loop. In this particular application moisture is removed by low temperature adsorption on molecular sieves. Progress of the drying is monitored continuously by a commercially available instrument in which moisture passes through a semipermeable foil to a capacitance element. The rate of reaction in the remote reaction zone is reflected continuously in the time rate of change of conversion as measured by in situ differential refractometry. Utilization of this system has permitted accurate measurement of the rate of ^{60}Co radiation induced polymerization under super-dry conditions. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 41481, 41493, 41494, 41583, 41619, 43734, 43752, 43863, and 43864.

41599 (AECL-3656) ANNULAR-DISPERSED TWO-PHASE FLOW AND CRITICAL HEAT FLUX. Moeck, E. O. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1970. 337p. Dep. CFSTI (U. S. Sales Only). AECL $7.00.

Liquid film flow rates and critical heat fluxes were measured in a concentric, internally heated annulus in which steam and water flowed upwards at pressures and velocities of interest in nuclear reactors. Film growth rates were obtained from measurements of film flows on an unheated surface down-stream of the heater. From these, droplet deposition fluxes were calculated and an equation for the entrainment flux is proposed. A theoretical expression for droplet velocity, obtained from droplet interchange between film and core, was linked with a critical Weber number to predict maximum stable drop diameters. These agreed with available data. A variable density film model, coupled with the core model, gave acceptable predictions of film thicknesses and crest velocities in air-water flow. (auth)

41600 (AEEW-R-578) DRYOUT TESTS ON AN INTERNALLY HEATED ANNULUS WITH VARIATION OF AXIAL HEAT FLUX DISTRIBUTION. Little, R. B. (Atomic Energy Establishment, Winfrith (England)). May 1970. 76p. Dep. CFSTI (U. S. Sales Only). UK 10s.

The results of dryout tests are reported where three types of non-uniform heat flux distribution were studied and the results compared with data from a uniform axially heated test section of the same nominal geometry. The studies were completed on an annular geometry with an inner 0.625 in. diameter, 12 ft long heated rod positioned in an unheated 0.825 in. shroud tube. The tests involved water coolant at pressures of 750 and 1,000 lbf/in^2 with mass velocities between 1.0 and 3.0×10^6 lb/hr ft^2. Three different methods of dryout detection instrumentation were used and the studies also covered a 4:1 range of heater tube wall thickness. (auth) (UK)

41601 (EUR-4471) THERMAL INSULATION OF VESSELS IN PRESTRESSED CONCRETE. Final Report. Wuerdig, P. (Deutsche Babcock und Wilcox A. G., Oberhausen (West Germany)); Freour, A. (Societe pour l'Industrie Atomique, Paris (France)). 4 Mar 1970. Contract 016-63-10-TEGC. 118p. (In German and French). Dep. CFSTI (U. S. Sales Only). EUR FF 18,35.

The use of prestressed concrete reactor vessels offers numerous advantages, from the point of view of both economy and safety, especially for gas-cooled reactors. The use of these vessels, however, imposes the need for internal thermal protection capable of maintaining the steel liner and the concrete at a temperature below about 80°C at all times. The development of effective thermal protection systems raises serious technical problems, many of which have been studied under Euratom contracts. The main results obtained in the course of a development contract are summarized. The purpose of the contract was to develop and prove a sturdy system of thermal protection which would be cheap, safe and easy to install. The novel feature of this system is that the thermal waste evacuation circuit is integrated in the vessel within the steel liner, where it is immersed in the insulating layer. Depending on whether the "gas screen" or "water screen" variant is employed, the fluid of the circuit is water or the primary fluid of the reactor. A considerable measure of prefabrication is possible with this system, i.e., the best conditions of finish and inspection are possible without much interference with the construction of the vessel. A detailed study of the cost of thermal protection of the vessel of an AGR type reactor is included. (auth)

41602 (NP-9914) HIGH TEMPERATURE HEAT TRANSFER CIRCULAR CHANNEL EXPERIMENT INTRODUCTION AND RIG CALIBRATION. Project DRAGON. Dalle Donne, M.; Bowditch, F. H. (Atomic Energy Establishment, Winfrith (England)). Dec 1960. 28p. (DP-Report-11). Dep. CFSTI.

In the past considerable attention was given to forced convection heat transfer from or to surfaces whose temperatures differed little from that of the fluid passing over them. Less attention was given to the condition where fluid and surface temperature differ considerably: such a condition will exist in the Dragon Reactor, both in the reactor cooling channels and in the heat exchangers, and for the expected reactor operating conditions insufficient data are available. The object of the experiment described is to provide some of the information required for the reactor design by studying forced convection heat transfer and friction coefficients at high temperature for the flow of gases through smooth tubes. The experiment is being carried out in a number of stages. The equipment, and its calibration for stage I, which is to establish experimental and analytical techniques, are described. (auth)

41603 (NP-10127) AN EXPERIMENTAL INVESTIGATION INTO THE HEAT TRANSFER CHARACTERISTICS OF A DELAY BED USING CROSS-FLOW COOLING. Project DRAGON. Enzmann, H. F. (Atomic Energy Establishment, Winfrith (England)). Jan 1961. 16p. (DP-Report-18). Dep. CFSTI.

An experiment was carried out to investigate the heat transfer characteristics of a cross-flow arrangement of charcoal filled U-tubes and coolant tubes envisaged in a design study for the delay bed for the fission product clean-up plant in the Dragon Reactor Experiment. The temperatures at different points in the tube walls and of the intermediate plate were measured with varying amounts of heat transferred from the charcoal bed to the coolant. The bed was heated by passing an electrical current axially through it. (auth)

41604 (NP-10675) PRESSURE DROP IN CHARCOAL BEDS. Project DRAGON. Enzmann, H. F. (Atomic Energy Establishment, Winfrith (England)). Jul 1961. 19p. (DP-Report-42). Dep. CFSTI.

Pressure drop measurements on charcoal beds are reported. With increasing flow rate the bed height remained the same and the pressure followed the pressure drop curve with a constant voidage coefficient up to the break-away point. The effects of mesh size were studied. Data are given in graphs. (M.C.G.)

41605 (NP-10940) HEAT TRANSFER ANALYSIS AND EARLY OUT OF PILE TEST RESULTS ON PLUTO LOOP A. Project DRAGON. Blake, J. P. H.; Saunders, R. A. (Atomic Energy Establishment, Winfrith (England)). Oct 1961. 39p. (DP-Report-55). Dep. CFSTI.

Heat transfer calculations required in the design of the in-pile section of PLUTO Loop "A", a gas cooled loop testing a section of fuel element for the H.T.G.C. Reactor, were complicated by the restrictions on space and operational requirements in PLUTO.

Two computer programs were prepared to aid in the heat transfer analysis which led to the final design. Off design point operation has also been examined, and the original specification has been met, in agreement with PLUTO operating requirements. Results of preliminary tests with electrical heating in an out of pile assembly agree closely with the calculated values. (auth)

41606 PROCESS FOR TRANSPORTING THERMAL ENERGY. Hilberath, Friedrich: Teggers, Hans (to Union Rheinische Braunkohlen Kraftstoff Aktiengesellschaft). British Patent 1,191,995. 13 May 1970. Priority date 16 Jan 1968, Germany.

A process for transporting thermal energy, such as might originate from a nuclear reactor, to another place where the heat is required consists of using the heat at the production site for the catalytic cracking of methane, cooling the cracking gas, carrying the cracking gas to the site where heat is required and there reforming the methane to release the heat. The methane is then recirculated to the cracking site for reuse. (B.L.M.)

Isotope Technology

Refer also to abstracts 41421, 41428, 41534–41536, 41593, 41594, 41596, 41633, 41635, 41707, 41708, and 42089.

41607 (AD–704790) PARAMETRIC ANALYSIS OF A DEEP SEA RADIOISOTOPIC THERMOELECTRIC GENERATOR EMPLOYING A HEAT PIPE. Ewers, Benjamin James Jr. (Naval Postgraduate School, Monterey, Calif.). Jun 1969. 71p. CFSTI. Thesis.

A parametric design analysis was performed using a heat pipe in an existing deep sea Radioisotopic Thermoelectric Generator (SNAP-21). Heat is transferred from an annular fuel pellet to an annular thermoelectric generator through a connecting heat pipe. The fuel pellet is fully shielded so that the thermoelectric generator is easily removable. Overall efficiency and the weight of major components were determined for varying fuel radii of from 1.3 to 1.7 inches and for varying insulation thicknesses of from 1.0 inch to 2.0 inch. The analysis indicates that there is a particular fuel radius (at constant insulation thickness) at which minimum weight is reached, while the maximum overall efficiency is obtained at a larger fuel radius. The median design has an overall efficiency (at the beginning of life) of 5.4% and a total weight of 570 lbs. These design results, when compared to the existing SNAP-21 design, give an increase in overall efficiency of at least 7% and a reduction in total weight of 12%. (auth) (USGRDR)

41608 (AECOP–330) RESOLUTION OF A MULTICOMPONENT CASCADE WITH TWO KEY WEIGHTS AND MULTI-FEEDS AND WITHDRAWALS. de la Garza, A. (Atomic Energy Commission Combined Operations Planning, Oak Ridge, Tenn.). 1 Dec 1969. Contract W-7405-eng-26. 15p. Dep. CFSTI.

An extension of the previously reported constant key weight cascades for multicomponent isotope separation is presented. Basic equations are given for the resolution of the productivity of a multicomponent cascade having an upper and a lower section with different key weights. Multi-feeds and withdrawals are also permitted. This cascade should prove useful in investigating the cascade management of minor isotopes, as well as in the separation of a middle component in a single cascade. (auth)

41609 (AI-AEC–12943) LARGE RADIOISOTOPE HEAT SOURCE CAPSULE PROGRAM. TOPICAL REPORT NO. 10. CREEP OF T-111 RADIOISOTOPE CONTAINMENT VESSELS UNDER INCREASING PRESSURE. Ferry, P. B. (Atomics International, Canoga Park, Calif.). 3 Jul 1970. Contract AT(29-2)-2338. 114p. Dep. CFSTI.

A program designed to develop and test an analytical model for creep of T-111 fuel capsule under operating conditions is described. The results of testing the model under increasing pressure at 2000°F using He pressurizer gas are summarized. (J.R.D.)

41610 (AI-AEC–12966) LARGE RADIOISOTOPE HEAT SOURCE CAPSULE PROGRAM. TOPICAL REPORT NO. 11. MATERIALS COMPATIBILITY. Brengle, Robert G. (Atomics International, Canoga Park, Calif.). 3 Jul 1970. Contract AT(29-2)-2338. 108p. Dep. CFSTI.

Various interfaces of T–111 (Ta–8W–2Hf) Ta–10W, TZM (Mo–0.5 Ti–0.08Zr, 0.02C), Nb–1Zr, Mo–50Re, Pt–20Rh, AXF–5Q graphite, RPG graphite, alumina, platinized alumina and iron titanate were tested in combinations and at temperatures that would simulate a radioisotope heat source. Testing was conducted at 2000, 2250, and 2500°F for times between 10 and 1000 hours in a hard vacuum. Results showed that the refractory metals are compatible except for an apparent instability in the TZM. Hard phases were observed in the graphite to metal interfaces and in the interdiffusion areas of the refractory metals in contact with Pt–20Rh. A new emittance coating, platinized alumina, was tested and found to be compatible with T-111. A useful equation for predicting interdiffusion distances in T-111 vs. Pt–20Rh was derived. (auth)

41611 (AI-AEC–12967) LARGE RADIOISOTOPE HEAT SOURCE CAPSULE PROGRAM. TOPICAL REPORT NO. 12. TRANSIT CAPSULE PROCESS METALLURGY. Brengle, Robert G. (Atomics International, Canoga Park, Calif.). 3 Jul 1970. Contract AT(29-2)-2338. 50p. Dep. CFSTI.

T-111 (Ta–8W–2Hf), Ta–10W and Pt–20Rh piece parts have been fabricated for the Transit and Pioneer flight qualification programs. The metallurgical characteristics of the piece parts are described by using photomicrographs of various areas. Even though some process variations took place during the program the photomicrographs from the various capsules show that very little difference occurs in the final microstructure. (auth)

41612 (LA–4476) QUARTERLY STATUS REPORT ON ^{238}Pu SPACE ELECTRIC POWER FUEL DEVELOPMENT PROGRAM, JANUARY 1–MARCH 31, 1970. (Los Alamos Scientific Lab., N. Mex.). Jul 1970. Contract W-7405-eng-36. 17p. Dep. CFSTI.

Efforts during the quarter were primarily devoted to the production of solid solution cermets (SSC). A total of 1.1 kg of 90 wt % $^{238}PuO_2$–ThO_2 was prepared in the size range 105 to 177 μ. Production processes are outlined along with processes for coating ceramic powder by chemical vapor deposition of Mo. A series of property tests were conducted on PuO_2–ThO_2–Mo cermets and on simulated cermets. Results of these and compatibility tests with refractory alloy container material are summarized. Results of radiation effects testing are also summarized with emphasis on He production and release and dose rates from SSC. (J.R.D.)

41613 (MLM–1357) BIFOLD NUCLEAR POWER SOURCE. Stubbins, W. F. (Mound Lab., Miamisburg, Ohio). 30 Sep 1966. Contract AT(33-1)-Gen-53. 13p. Dep. CFSTI.

The dual role of a ^{238}Pu assembly as an isotopic heat source for modest reliable power and as a reactor for large demand power is proposed. The term bifold designates the two distinctly different modes of power production in a single device. The modest power level of a few kilowatts (thermal) provides energy for the usual isotopic source applications and for monitoring, control, and standby reactor functions. The demand power levels of hundreds of kilowatts for duty cycles from one to ten or more percent can be provided over many years of use by ten or less kilograms of plutonium metal. The bifold source unites both SNAP technologies in a mission-matched power production. (auth)

41614 (ORNL–TM–3069) INVESTIGATION OF DEFORMATION IN RECTANGULAR ^{137}Cs SOURCES. Bradley, N. C.; Ottinger, C. L. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 29p. Dep. CFSTI.

Results are presented of inspection and data review of ^{137}CsCl strip sources to determine causes of deformation in these standard assembly sources which had passed all applicable tests. Information is included on source design, encapsulation materials, fuels, assembly, and testing. No single cause was found for the deformations. Indications of areas in which fabrication methods can be improved were found and recommendations based on these findings are presented. (J.R.D.)

41615 (ORNL–TM–3089) ISOTOPE PROGRAM (5000) PROGRESS REPORT FOR QUARTER ENDING JUNE 30, 1970. Gillette, J. H. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 10p. Dep. CFSTI.

About 500 specimens of encapsulated isotopes were fabricated for use in reactor flux and neutron energy measurements. Fabrication of large-area and thick targets by rolling is reported with the aid of the Rocky Flats facilities. Production of tritium targets having more reproducible neutron production by ^{3}H sorption on Ti or Zr films is reported. In other work, production of high-purity Dy, Sm, and Er metal isotopes is reported. Isotopic separations for production of ^{199}Hg and ^{201}Hg and stable isotopes of Fe, Nd, and Sn are in progress. Radioisotopic separations include ^{233}U collection. Information is included on 180° sector isotope separator operation, isotopic material inventory, radioisotope preparation, and stable isotope preparation. (J.R.D.)

41616 (SC–PR–70–435) AEROSPACE NUCLEAR SAFETY PROGRAM. Quarterly Report, April 1–June 30, 1970. Illing, R. G. (comp.) (Sandia Labs., Albuquerque, N. Mex.). Jul 1970. 61p. Dep. CFSTI.

Research and development devoted to radioisotope safety support involving SNAP-27, TRANSIT, PIONEER/VIKING, ISOTOPE BRAYTON Heat Source and Dart minithruster are reported. Activities in

safety technology research were directed toward advanced fuels safety, recovery and tracking methods, flight tests, reentry, models of abort, and computer codes. (J.R.D.)

41617 (TID–25464) RADIOISOTOPE-POWERED CARDIAC PACEMAKER PROGRAM. Quarterly Progress Report for Phase II. (Nuclear Materials and Equipment Corp., Apollo, Pa. Energy Conversion Div.). 30 Jun 1970. Contract AT(30-1)-4189. 31p. (NUMEC–4189-1). Dep. CFSTI.

Progress in the development of a radioisotope-powered cardiac pacemaker is reported and emphasizes cost reduction studies and associated pilot production engineering studies. Improved equipment and methods for inspecting components during fabrication and assembly are described. Data on prototype components used in bench tests and for implantation in dogs are presented, and include life test data on the thermocouple tapes for the production model. An ultrasonic technique for detecting microcracks in Ta-10W rods used for fabricating the inner fuel capsules is described and evaluated. Methods developed for reducing the costs of producing components and assemblies are presented. (L.C.L.)

41618 (TID–25482(App.)) THE DESIGN, DEVELOPMENT AND DELIVERY OF HIGH TEMPERATURE VACUUM INSULATION SYSTEMS FOR SNAP-21 THERMOELECTRIC POWER SYSTEM. Final Report. Niendorf, L. R. (Union Carbide Corp., Tonawanda, N. Y. Linde Div.). [nd]. Contract AT(30-1)-3691. 114p. Dep. CFSTI.

For Minnesota Mining and Mfg. Co., St. Paul.

Sections in the appendix are included on getter requirements, calculations for proof testing, insulation materials, equations for temperature distribution in rods having one dimensional heat conduction, neck tube temperature profiles, load sharing equations, support system spring constants, prototype performance, heat loss calculations, acceptance test plans, and drawing identification. (J.R.D.)

41619 HEAT-GENERATING APPARATUS. (to Sanders Nuclear Corp.). British Patent 1,198,862. 15 Jul 1970. Priority date 27 Jun 1966, United States.

A heat-generating apparatus comprised a heat source of the type using a flameless exothermic reaction to generate the heat and a fluid jacket in thermal conducting relationship with the heat source and arranged to heat the fluid. A fluid inlet conduit is arranged to convey the fluid from a fluid inlet to the jacket, and outlet conduit means convey the fluid from the fluid jacket to a fluid outlet. A heat exchanger is arranged in a fluid path parallel with the path through the fluid outlet conduit. The apparatus is provided with a thermoelectric generator having heated and cooled portions. The electricity produced by the generator is used to power a motor-driven pump, which circulates the fluids through the apparatus. The apparatus is particularly adapted to heating apparatus worn by undersea divers. Any suitable nuclear fuel may be employed as the heat source. (B.L.M.)

41620 FIRST ATOMIC PACEMAKER IN HUMAN BEING. Int. At. Energy Agency Bull.; 12: No. 3, 24-5(1970).

Since April 1970, the heart of a 58 year old Frenchwoman has been beating regularly with the help of impulses from a ^{238}Pu-fueled pacemaker. This is the first time that such a device has been used in a human being. An important feature of the pacemaker is that the device lies quiescent for as long as the natural heartbeat is adequate to keep up normal blood flow. When the heart-rate falters, the pacemaker takes over automatically. 90% of the radiation from the Pu source is said to be absorbed within the protective sheath of the tantalum and platinum capsule. The amount of radiation actually released in a year is said to be equivalent to no more than the woman would receive from a single chest x-ray. (L.C.L.)

41621 WORK AT THE LABORATORY FOR ISOTOPE TECHNIQUES. Vogg, H. (Laboratorium fuer Isotopentechnik, Karlsruhe, Ger.). Kerntechnik; 12: 197-201(May-Jun 1970). (In German and English).

The work carried out at the Laboratory for Isotope Techniques of the Gesellschaft für Kernforschung mbH, Karlsruhe, includes the use of small sealed radioactive sources, the use of open radionuclides for labeling purposes, and the use of activation techniques. Some examples of studies carried out up to now are still in progress, and outlines of future prospects are described. (auth)

41622 FABRICATION OF A ^{238}Pu HEAT SOURCE FOR A CARDIAC PACEMAKER. Fleming, D. L.; Brewer, C. O.; Coffey, D. L. (Monsanto Research Corp., Miamisburg, Ohio). Contract AT(33-1)GEN-53. Nucl. Appl. Technol.; 8: 536-8(Jun 1970).

A ^{238}Pu-powered heat source for use in an experimental model of a cardiac pacemaker was developed. The encapsulated source has a thermal power of 0.134 ± 0.013 W and is fueled with three ^{238}Pu metal pins. Each fueled pin was TIG welded into a tantalum inner capsule. The inner capsules were electron beam welded into Hastelloy C middle capsules. These middle capsules were platinum plated to prevent a reaction between the Hastelloy C and the titanium outer capsules. Three middle capsules were electron beam welded into each outer capsule. (auth)

41623 CONCENTRATION OF HEAVY WATER IN SIEVE-PLATE COLUMN. ANALYSIS OF THE STEADY STATE CHARACTERISTICS AND THE DEGREE OF APPROACH TO EQUILIBRIUM. Takamatsu, Takeichiro (Kyoto Univ.); Sayama, Hayatoshi; Kurihara, Yasuo; Maruyama, Mikio. Nippon Genshiryoku Gakkaishi; 12: 368-75(Jul 1970). (In Japanese).

A water distillation experiment with sieve-plate column operated under atmospheric pressure under the condition of total reflux into concentrated heavy water from 0.048D at.% water is described. Measurements were made of the Murphree tray efficiency, liquid hold-up in each section, and froth height, which are the data necessary for analyzing the rate of approach to equilibrium of a distillation column. The experimental results are compared with the values determined by established methods for predicting tray efficiencies. Equations are derived which describe the transient behavior of the plate column under total reflux with finite holdup in the condenser and reboiler. The observed results agree fairly well with values computed from the equations except when the holdup in the condenser is assumed to be negligible. The equation relating to time the degree of approach to equilibrium reveals that the time required to reach 99% equilibrium is 16.5 days. (auth)

41624 RADIOISOTOPES AND RARE METALS. Kobayashi, Masatosi (Japan Atomic Energy Research Inst., Oarai). Kogyo Rea Metaru; No. 42, 58-65(Dec 1969). (In Japanese).

Utilization of radioisotopes and radiation sources are described. Use of sealed and unsealed radiation sources is discussed with emphasis on ^{60}Co gamma sources. Neutron sources, the sales of radioisotopes in Japan, procedures for producing radioisotopes, and production of transuranic radioisotopes are reviewed. The future of radioisotopes and rare earth metals is discussed. In radioisotope production, the cost of materials to be irradiated is insignificant. Rare earth element radioisotopes of high specific activity are a future possibility. The structure and use of the radioisotopic battery are described; and possibility of increasing the radioisotope demand is forecast. (Japan)

41625 INVESTIGATION INTO THE WEAR OF A ROLLING BEARING WITH IRRADIATED BALLS. Jost, H. (Zentralinstitut fuer Physikalische Chemie, Berlin); Drassdo, R.; Wagner, K.; Hueck, W. Maschinenbautechnik; 18: 440-5(Aug 1969). (In German).

The wear of rolling steel ball bearings was studied by radioactive isotope labeling and by determination of the ball surface in its dependency on duration of experiment, pressure, rotation velocity, and lubrication. Wear increased with duration, pressure, and rotation velocity. Although lubrication diminished wear, it significantly increased corrosion of the steel balls. Bearings treated by the superfinish procedure showed more wear than those smoothed by grinding. (tr-auth)

Materials Testing

Refer also to abstracts 41477, 41566, 41571, 41573, 41574, 41609, 41617, 41625, 42229, and 43737.

41626 (BMI–1887) INVESTIGATION OF THE INITIATION AND EXTENT OF DUCTILE PIPE RUPTURE, PHASE II. Progress Report, April–June 1970. Eiber, Robert J.; Maxey, Willard A.; Duffy, Arthur R.; Atterbury, Thomas J. (Battelle Memorial Inst., Columbus, Ohio). Jul 1970. Contract W-7405-eng-92. 4p. Dep. CFSTI.

Activities directed toward determining whether propagating fractures in pipe under subcooled conditions will be arrested when the pressure decay is retarded, are reported. Configuration for proposed experiment 28 is discussed and illustrated. (J.R.D.)

41627 (BNWL–1362) CREEP ANALYSIS OF STATICALLY INDETERMINATE BEAMS. Sutherland, W. H.; Watwood, V. B. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 61p. Dep. CFSTI.

A general finite element analysis procedure has been defined which will permit the creep analysis of statically indeterminate beams of arbitrary cross section using the same structural idealization as used for conventional beam theory. Furthermore, any incremental functional representation for the creep law can be accommodated. Provision has been made in the formulation to consider the time-dependent loading condition resulting from material

swelling and time-varying mechanical and thermal loads. Results are presented for a cantilever beam and a conceptual Fast Test Reactor (FTR) flow duct. (auth)

41628 (DP-Report-143) APPLICATIONS OF X-RAY MICROANALYSIS AND X-RAY PROJECTION MICRORADIOGRAPHY TO THE STUDY OF HIGH TEMPERATURE REACTOR FUELS. Project DRAGON. Theisen, R.; Schleicher, H. W. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jan 1963. 24p. (CONF-630103-25). Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng. From Fuel Element Symposium, Bournemouth, Eng.

The electron probe micro-analyzer excites the atoms at a particular point of a metallographically polished surface by means of a focused electron beam of diameter less than one micron. A complete x-ray spectrum is emitted which is analyzed in two curved crystal spectrographs. A special attachment readily transforms the microprobe into a high resolution x-ray projection microprobe with x-ray microfocus. The electron beam is focused by two magnetic lenses on a target, consisting of thin metal foil. The monochromatic x-ray emerging from this microfocus is differentially absorbed by the components of the object and projects an enlarged image of the object on a photographic film. The technique is used for determination of thickness of core and coating of fuel pellets, and examination for inclusions in the carbon shell. (auth)

41629 (LMEC-70-10) FRICTION AND WEAR SCREENING TESTS OF MATERIALS IN SODIUM. Hoffman, N. J.; Goggin, D. E.; Droher, J. J. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). 15 Jul 1970. Contract AT-(04-3)-700. 173p. Dep. CFSTI.

The results of a number of screening tests on the friction and wear behavior of materials in contact within a sodium environment are presented and interpreted. The report is divided into two sections: considerations for the designer, and experimental material screening and analytical studies. The bulk of the data concerns the wear coefficient and coefficient of sliding friction at 900 or 1200°F in sodium fluid. Results from studies of coefficient of static friction and self-welding characteristics are also discussed. Materials studied included metals and alloys and carbides. (auth)

41630 (NP-10079) PRELIMINARY REPORT ON DRY BEARINGS FOR THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Fricker, H. (Atomic Energy Establishment, Winfrith (England)). Mar 1961. 19p. (DP-Report-24). Dep. CFSTI.

Information on the tests with dry bearings carried out within the Dragon Project is presented. In a proper dry bearing the two surfaces touch each other. No attempt to separate the surfaces by means of an artificially added lubricant is made. In a wider sense a bearing may also be called dry if a dry lubricant only is applied. Both types of bearings are discussed. On the other hand, a gas bearing is quite different because the moving surfaces are separated by a gas film. (auth)

41631 (ORNL-TM-3014) PHASE REPORT NO. 115-1 ON STRESS INDICES FOR SMALL BRANCH CONNECTIONS WITH EXTERNAL LOADINGS. Rodabaugh, E. C. (Battelle Memorial Inst., Columbus, Ohio). Aug 1970. Contract W-7405-eng-26; Subcontract 2913. 68p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

Stress indices and simplified design formulas were developed for use in the stress analysis of small branch connections in Class I piping systems as required by the ANSI Standard, Code for Pressure Piping, Nuclear Power Piping ANSI B31.7. Equations are given for reducing the set of nine moments which act on a branch connection, and whose numerical values are obtained from a piping flexibility analysis to two resultant moments. Stress indices to be used with these resultant moments are empirically developed from existing test data; and design rules are proposed for inclusion in ANSI B31.7. The effects of direct shear force loadings on branch connections are also discussed. (auth)

41632 (TID-25479) COMPARISON OF USAS B31.7 PLASTIC FATIGUE ANALYSIS WITH TEST DATA ON PIPING COMPONENTS. Phase Report No. 115-2. Rodabaugh, E. C. (Battelle Memorial Inst., Columbus, Ohio). Feb 1969. 24p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

The Nuclear Piping Code, USAS B31.7, and the Nuclear Vessels Code, ASME Boiler Code Section III, are based on almost identical design philosophies. However, these two codes differ in several detailed aspects one of which involves the limitation on secondary stresses to $3\,S_m$, where S_m is the basic allowable stress intensity. Under certain conditions, B31.7 permits the secondary stress to exceed $3S_m$, provided not more than 250 cycles of such loading occur and a prescribed modification of the fatigue analysis is used. The B31.7 design procedure is compared with fatigue tests in which the test loadings gave secondary stresses which did exceed $3S_m$. Details of comparison procedure are included along with data on moment loading, pressure loading, and mention of thermal gradient loading development status. (J.R.D.)

41633 GAMMA CAMERA MAINSTAY OF TESTING ON UTILITY'S PIPELINES. Mater. Eval.; 28: 26A-8(Aug 1970).

The nondestructive testing system used by the Rochester Gas and Electric Co. to guarantee high-quality weldments in its pipeline system consists of a portable gamma camera with an ^{192}Ir source and a mobile on-site darkroom. Three weld radiographs are made as soon as the weld is cool enough to touch and are developed immediately in the darkroom. The manpower requirements and radiation safety procedures are described. The failure rate from girth weld defects has dropped from 10 per 100,000 miles of piping in 1950 to nearly zero defects in 1965, or a failure rate of 0.00000126%. (L.C.L.)

41634 STATISTICAL EVALUATION OF THE RESULTS OF NONDESTRUCTIVE TESTS CARRIED OUT ON SAP REACTOR PRESSURE TUBES. Albertini, Carlo; Basile, Domenico (Joint Nuclear Research Center, Ispra, Italy). Mater. Eval.; 28: 182-8(Aug 1970).

Several lots of SAP pressure tubes have been examined by ultrasound. The detected defects have been statistically analyzed, and, by the Kolmogorov method, the distribution law of these defects has been determined. Furthermore, the defect distribution of lots fabricated with different techniques has been compared and possible existing correlations between defect distribution and mechanical characteristics have been attempted. (auth)

41635 CONTROVERSY IN LEAK TESTING: HELIUM VS RADIOISOTOPE. Anjard, Ronald P. (General Motors Corp., Kokomo, Ind.). Mater. Eval.; 28: 169-72(Aug 1970).

There has been some question as to what leak-testing techniques have space-age reliability for the evaluation of non-hermeticity of electronic components. The advantages and disadvantages of both helium mass spectrometry and radioisotope tracer testing are presented. Neither system indicates an absolute leak rate, but each gives a value based on the total testing conditions and the flow modes involved. Mathematical models of both systems are provided for the reader for close approximations of the leak rate. (auth)

41636 NONDESTRUCTIVE TESTING METHODS FOR ZIRCALOY TUBES. Krohm, G. (NUKEM-Nuklear-Chemie und -Metallurgie GmbH, Hanau, Ger.). Atomwirt., Atomtech.; 15: 392-3(Aug 1970). (In German).

Nondestructive testing of Zircaloy fuel element tubes encompasses continuous testing for material defects as well as determination and recording of tube geometry. Ultrasound procedures permit determination of material defects and wall thickness. For determination of the external diameter, measurement by induction is performed. Eccentricity, ovality, and internal diameter are measured by a combination of ultrasound and induction procedures that allows a magnitude of various application possibilities. (tr-auth)

Radioactive Material Handling

Refer also to abstracts 41384, 41385, 41405, and 42097.

41637 (CEA-N-1303) THERMAL CONDUCTIVITY INSTALLATION FOR IRRADIATED SOLIDS. Mansard, Bernard; Lauger-Hache, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1970. 27p. (In French). Dep. CFSTI (U. S. Sales Only).

Processes and apparatus used in hot cells for measuring the thermal conductivity of various irradiated materials up to 1000°C are described. (auth) (France)

41638 (DPST-69-444) REPORT ON THE PROPOSAL OF E. I. DU PONT DE NEMOURS AND COMPANY FOR THE PERMANENT STORAGE OF RADIOACTIVE SEPARATIONS PROCESS WASTES IN BEDROCK ON THE SAVANNAH RIVER PLANT SITE. Benedict, Manson; Cooke, J. Barry; Deere, Don U.; Garrels, Robert M.; Graham, Jack B.; Wolman, Abel (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 22 May 1970. Contract AT(07-2)-1. 57p. Dep. CFSTI.

A proposal that radioactive wastes from the Savannah River Plant be stored permanently in caverns to be excavated in bedrock on the Savannah River Plant site was evaluated. Construction of a shaft and several tunnels is suggested to disclose the number and degree of fissures or fractures encountered. Topics covered include: geology, geochemical aspects of waste storage, hydrologic implications of the geology, underground construction, and alternative methods and costs. (M.C.G.)

41639 (K-L-6232) CRITICALITY CONSIDERATIONS IN BASKET DESIGN FOR IRRADIATED FUEL SHIPMENT. Newlon, C. E. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 16 Apr 1969. Contract W-7405-eng-26. 14p. (CONF-690609-28). Dep. CFSTI.

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash.

Design of a fuel basket for shipment of BONUS reactor fuel in a 30-ton ATCOR shipping container is described. The description is illustrated using slides. (J.R.D.)

41640 (K-L-6255) NUCLEAR SAFETY ANALYSIS OF MODERATION-CONTROLLED 48-IN.-ID HEAVY-WALL UF_6 CYLINDERS. Newlon, C. E.; Taylor, R. G. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 10 Aug 1970. Contract W-7405-eng-26. 12p. Dep. CFSTI.

The analysis includes cylinder data, information on hydrogen moderation control, criticality safety, array safety, and data correlations. Analytical results show that the cylinders appear to be safe at ^{235}U enrichments to 4.5% under moderation control. (J.R.D.)

41641 (KFK-1030) ANNUAL REPORT OF THE DEPARTMENT OF DECONTAMINATION MANAGEMENT, 1968. Krause, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Feb 1970. 85p. (In German). Dep. CFSTI (U. S. Sales Only).

For the year 1968, operations of the decontamination section of the nuclear center Karlsruhe were compiled. To handle radioactive effluents, a vapor compression evaporator with a capacity of 4.5 m^3 of waste water became operational. Solid waste amounted to 730 m^3 and was disposed in a salt mine. For incineration, an offgas cleaning system using ceramic candle filters greatly enhanced operational safety. The decontamination squad was alerted 49 times; of these alerts, seven were genuine emergency situations. Laboratory studies were continued, and preliminary results were reported on fixation of radioactive residues in bitumen, cement, glass by vitrification, and ceramics produced by chemothermal reactions. Research on surface decontamination established a procedure for production of firmly fixed and reproducible contamination and also a highly efficient decontamination mixture of $NH_4HF_2 + (NH_4)_2 S_2O_8$. (H.B.G.)

41642 (NP-18338) NATIONAL COMPETENT AUTHORITIES LIST NO. 3. Regulations for the Safe Transport of Radioactive Materials, 1967 Edition. Safety Series No. 6. (International Atomic Energy Agency, Vienna (Austria)). Jun 1970. 20p.

A list of the names and addresses of world-wide national authorities responsible for the safe transport of radioactive materials is presented. (L.C.L.)

41643 IMPROVEMENTS IN AND RELATING TO CONTAINERS. Berthaud, Jean; Palli, Claude (to Commissariat a l'Energie Atomique). British Patent 1,192,128. 20 May 1970. Priority date 13 Oct 1967, France.

A tubular container is described for conveying materials, particularly spent nuclear fuel elements, from one point to another. Means are provided for the element to be gripped at one end with tongs and to be deposited by means of the other end on the mouth of a receiving vessel. (B.L.M.)

41644 A METHOD OF LABELLING A PROCESSED NUCLEAR FUEL. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,196,297. 24 Jun 1970. Priority date 1 Jul 1967, Germany.

A method for labeling a processed nuclear fuel consists of homogeneously mixing at least one radionuclide with the nuclear fuel leaving the processing plant. Preferably, several γ-emitting radionuclides having half-life periods substantially different from each other are used. Labeling the nuclear fuel renders it readily identifiable and locatable independently of form and shape. (B.L.M.)

41645 IMPROVEMENTS IN AND RELATING TO THE REMOTE ATTACHMENT AND REMOVAL OF PROTECTIVE BELLOWS. Fortin, Marcel; Townsend, Eric (to Commissariat a l'Energie Atomique). British Patent 1,197,768. 8 Jul 1970. Priority date 29 Dec 1966, France.

A device is described for the remote attachment and removal of a protective bellows seal to and from a member such as a manipulator located within a sealed enclosure and that might be used in nuclear engineering or chemistry. Two generally parallel members extend from a base, and a ledge extends from each member at a region remote from the base. The mutually facing inner surfaces of the ledges are spaced apart to define an elongate slot between the ledges. The inner surfaces are defined by first, second, and third portions located successively in the direction of the length of the slot. Each inner surface of the first portion has formed in it a rectilinear groove extending in the elongate direction. Each inner surface of the second portion is defined by an arcuate cut-out portion of the ledge and has a groove formed in it extending in the same direction and forming an extension of the groove in the first portion. Each inner surface of the third portion extends rectilinearly in the same direction and is ungrooved and coated with an adhesive. The thickness of each inner surface of the third portion is less than that of the inner surfaces of the other portions. (B.L.M.)

41646 PROGRESS IN SAFEGUARDS SYSTEMS ANALYSIS. Shmelev, V. (International Atomic Energy Agency, Vienna). At. Energy Rev.; 8: 417-33(Jun 1970).

Technical details on some results of the Agency's Safeguards Systems Analysis are discussed. On the basis of purely technical assumptions it has been found that the cost of safeguards will represent only a small and continuously decreasing portion of the cost of nuclear energy production and a small and also decreasing part of the cost of the materials safeguarded. (P.C.H.)

41647 NOTES FOR THE GUIDANCE OF PERSONS CONCERNED IN THE CARRIAGE OF RADIOACTIVE SUBSTANCES BY SEA. Melbourne; Department of Shipping and Transport (1969). 50p.

Guidance on the legislative requirements to be met with the consigning and carriage of radioactive substances is presented. Areas covered include packaging, labeling, stowage, documentation, accidents and exposure, as well as exemptions. Classification of radionuclides into groups for transport purposes is given, together with safe distances for persons and undeveloped films or plates. (Australia)

41648 RADIOACTIVE SUBSTANCES. pp 226-37 of Requirements for Dangerous Goods and the Packing, Stowing, and Carriage of Dangerous Goods. Melbourne; Department of Shipping and Transport (1970).

Tables are presented for the handling of radioactive substances as required by the Australian navigation (dangerous goods) regulations. Requirements for labeling, stowage of large source packages, and segregation of radioactive substances are given, as well as tables of safe distances for persons and undeveloped film or plates, and classification of radionuclides into groups for transport purposes. (Australia)

41649 METHOD OF DISPOSAL OF RADIOACTIVE SOLIDS. Ryan, Leo F. (to Union Tank Car Co.). U. S. Patent 3,520,805. 21 Jul 1970. Filed 29 May 1967.

A method for removal and disposal of radioactive solids from a contaminated liquid, which employs a filter precoated with disposable finely divided ion exchange resin particles. When the resin particles are exhausted, the filter is cleaned by the simultaneous introduction of warm liquid and air in reverse flow, followed by a backwash cycle. The radioactive pre-coat material is allowed to settle from the cleaning and backwash liquids and is then centrifuged and discarded. (auth)

41650 FINAL DISPOSAL OF RADIOACTIVE WASTES. Ramdohr, H. (Friedrich Uhde GmbH, Dortmund, Ger.). Kerntechnik; 12: 242-8(May-Jun 1970). (In German and English).

After a survey of the methods available and the situation in the Federal Republic of Germany, solidification and final disposal of radioactive wastes in rock salt formations of deep geological strata seem to be the best practice. High active wastes are, in general, melted into glass or ceramics. The costs of solidification and final disposal are estimated to be about 1% of the generating cost of nuclear energy. (auth)

Vacuum Engineering

41651 (DP-Report-421) EXPERIMENTS WITH FLANGES USING THIN FOIL SEALS. Project DRAGON. Woodley, H. (Atomic Energy Establishment, Winfrith (England)). Feb 1966. 15p. Dep. CFSTI.

Tests have been made on a design of flange used for high vacuum applications. At the commencement of testing it was assumed that the design was satisfactory for high vacuum work and so all experiments were made with a view to assessing suitability for the containment of helium at high temperature and pressure.

Satisfactory results were not obtained with the original design whereby flat flanges are welded directly to pipe ends, mainly due to distortion caused by welding. Good results were obtained by modifying the design. However, difficulties encountered during assembly led to the conclusion that the design would prove too sensitive for installation in large quantities on a reactor assembly. (auth)

41652 ULTRAHIGH VACUUM DEVICE FOR STUDYING THE DECAY OF POTASSIUM TO ARGON IN VOLCANIC ROCKS. Bellon, H. (Paris Univ., Orsay, France); Moreaux, J. P.; Vassenaix, M. Vide: 25: 7-13(Jan-Feb 1970). (In French).

A vacuum and ultravacuum system conceived to study the presence of argon and its volume in volcanic rocks in order to determine their age is described. Two ultravacuum lines, one having a gas extraction use, the other having high purification use, are made of Pyrex glass transit base, soldered to UV bakable taps, opened and closed. Pyrex glass traction problems, which appeared a few months after building the whole thing, were such that a new Pyrex glass-Inox steel links had to be made. The behavior of the 4 A molecular sieves was studied. Pumping is done by a pumping device using the oil diffusion system until 10^{-6} torr pressure; ion pumps of the magnetron type do the following steps allowing higher vacuum to be obtained. A variable leak valve allows gas introduction into a 180° mass spectrometer having radii of 6 and 2.3 centimeters. Gas analysis is done by the static method. (auth) (France)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 41426, 41427, 41456, and 42776.

General Detectors and Monitors

Refer also to abstracts 41714, 41873, 41876, and 43605.

41653 (CSIRO-Trans-10070) STUDY OF THE POSSIBILITY OF USING NaI(Tl) CRYSTALS IN HEAT-RESISTANT BOREHOLE APPARATUS OF RADIOACTIVITY LOGGING. Vedekhin, A. F.; Gutorov, Yu. A.; Kuchernyuk, V. D. Translated by B. Bergmanis (Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia), from Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 209-15(1968). 15p. Dep. CFSTI (U. S. Sales Only).

A detailed study was carried out on changes in the counting characteristics of scintillation counters on heating the crystals up to 250°C. Changes in these characteristics caused by temperatures, were affected by the concentration of Tl in the crystal volume, the method of crystal growing, and the rate of its heating and cooling. Verification of the efficiency of FEU-66 photomultipliers with NaI(Tl) and Cs(Tl) crystals was carried out to 120°C. (Australia)

41654 (IN-1309) DEVELOPMENT OF A CONTINUOUS SAMPLER-MONITOR FOR THE LOFT CONTAINMENT ATMOSPHERE. Schindler, R. E.; Hammer, R. R.; Black, D. E.; Lakey, L. T. (Idaho Nuclear Corp., Idaho Falls). Jun 1970. Contract AT(10-1)-1230. 69p. Dep. CFSTI.

A Continuous Sampler-Monitor (CSM) has been developed to determine fission-product concentrations in the containment building atmosphere during the LOFT Integral Test Program. The specific objectives of the CSM installation in LOFT are to remotely sample and determine during the test the airborne noble gas, total iodine, and organic iodide concentrations in the containment atmosphere, and to monitor changes in total activity in the containment atmosphere. A small stream (1 to 3 liters/min) of the atmosphere is continuously drawn into a scrubber where the elemental iodine and most of the particulate fission products are washed into a stream of basic-thiosulfate scrubbing solution leaving noble gases, organic iodides, and hypoiodous acid in the gas stream. The scrubbed gas stream and the scrubbing solution flow in a common line to a sampling station located outside the containment building where they are separated. The gross activity levels of the separated streams are monitored, and samples of each stream are analyzed to determine the concentrations of individual nuclides in the containment atmosphere. (auth)

41655 (IRI-133-70-1) THE USE OF AN X-RAY DETECTOR IN ACTIVATION ANALYSIS. de Bruin, M.; Korthoven, P. J. M. (Interuniversitair Reactor Instituut, Delft (Netherlands)). [1970]. 8p. (CONF-700527-1). Dep. CFSTI (U. S. Sales Only).

From Symposium on Semiconductor Detectors for Nuclear Radiation, Munich, Germany.

The possibilities and usefulness of using x-ray detectors in activation analysis of medium weight and heavy elements are discussed. Results are presented for the determination of paladium in platinum. (W.H.K.)

41656 (SC-M-70-512) OPERATION AND MAINTENANCE INSTRUCTIONS WITH ILLUSTRATED PARTS BREAKDOWN. T446 TRITIUM ALARM-MONITOR. Includes T2071 Power Supply, T464 Battery Charger, and T449 Radiological Urinalysis Kit. (Sandia Labs., Albuquerque, N. Mex.). 15 May 1970. 114p. Dep. CFSTI.

The T446 tritium alarm monitor is a small portable air sampler which uses a flowthrough proportional detector for monitoring tritium and other radioactive gases. The T446 has range capabilities from 5 $\mu Ci/m^3$ to 10 Ci/m^3 and an adjustable alarm level. The principles of operation; inspection and maintenance procedures; troubleshooting; calibration; and preparation for use, storage, and shipment are described. (W.H.K.)

41657 (UCRL-50882) INSTRUMENTATION FOR MONITORING OF ^{85}Kr AND ^{3}H IN NATURAL GAS. Prevo, C. T.; Santomassimo, V. C. (California Univ., Livermore. Lawrence Radiation Lab.). 26 May 1970. 11p. (PNE-G-64). Dep. CFSTI.

A system using CaF_2(Eu) crystals to monitor natural gas from nuclearly stimulated gas wells for ^{3}H and ^{85}Kr is described. On-line monitoring is provided with sensitivities of 1.3×10^{-7} $\mu Ci/cm^3$ in 20 min for ^{85}Kr and 2×10^{-5} $\mu Ci/cm^3$ in 20 min for ^{3}H. (auth)

41658 NONPHOTOGRAPHIC ALPHA AUTORADIOGRAPHY AND NEUTRON-INDUCED AUTORADIOGRAPHY. Pilcher, Carl B. (Massachusetts Inst. of Tech., Cambridge); Chapman, Clark R.; Lebofsky, Larry A.; Kieffer, Hugh H. Science; 167: 1370-3(6 Mar 1970).

With a new combination of two techniques, (i) alpha-particle or fission fragment registration in thin polymer foils by etching and (ii) automatic counting and magnification of the etched perforations by local evaporation of a thin metal layer with an electric spark, the sensitivity of conventional photographic methods for determining quantity and spatial distribution of alpha emitters, fissile materials, and of elements undergoing (n, α) reactions can be drastically improved, without need for darkroom processing and microscopic evaluation. (auth)

41659 NUMERICAL ION TRAJECTORY CALCULATIONS IN AND MEASUREMENTS ON A DALY TYPE CONVERSION DETECTOR. Suurmeijer, E. P. Th. M.; Boers, A. L. (Univ. of Groningen, Netherlands). J. Phys., E (London): 3: 624-8(Aug 1970).

Numerical ion trajectory calculations in a simplified model of a Daly type conversion detector were performed to check how the impact point of an ion on the converter depends on the geometry of the conversion chamber, the point of entrance into the detector and the initial energy of the considered ion. A relation was deduced between the initial ion energy and the position of the converter for a central point of impact. With the chosen model dimensions the converter must be adjustable over 10 mm, in order to meet this 'central impact' condition for ions with initial energies up to 10 keV. The influence on the detection efficiency of inhomogeneities in the converter surface, the scintillator material and the cathode of the photomultiplifier can thus be eliminated. With the aid of the numerical results a conversion detector was built with an adjustable converter, suitable for nonsimultaneous detection of 0 to 10 keV positive ions, and an experimental verification was carried out. For the chosen configuration a good agreement existed between numerical and experimental results. The calculated ion trajectories therefore describe the real ion motion in the conversion chamber rather well. (auth) (UK)

41660 ELECTROSTATIC ANALYZER, 15 cm (10 Feb 1969) (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-2012).

13 drawings.

This instrument is an analytical and research tool to analyze charged particles, electrons, or ions, according to their kinetic energy. The Al dispersive elements consist of two spherical sector plates with radii of 13.3 and 17.1 cm. Electrons or ions are created in the source volume when uv light, x rays, electrons or ions interact with gaseous or solid matter. Following energy dispersion, particles are detected by an electron multiplier or other suitable detectors. The system is shielded by a double-layer magnetic shield (Molly Permalloy metal) to exclude ambient magnetic fields. Energy resolution is better than 0.1%. The fixed source chamber can be replaced by a rotatable chamber to allow angular distributions studies and, with the addition of a second analyzer, angular correlations can be made. Data collection is automatic. Adjustable-sawtooth de-biased voltages are applied to sector plates and signals are stored in a multichannel scaler whose channel advance is synchronized with sawtooth wave form. Each scan of a preset energy requires 40 msec. The number of repetitive scans depends on the requirements of the experiment. (F.S.)

41661 AMPLIFIER AND DIFFERENTIAL DISCRIMINATOR FOR A GAMMA COUNTER (8 Jul 1970) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-2010).

14 drawings.

The amplifier and differential discriminator, which are used with a γ counter, are essentially a single-channel pulse-height analyzer preceded by an amplifier with an external pulser. The pulser allows the energy of an unknown pulse to be determined from 5 keV to 2.5 MeV. The pulser employs the usual RC-pulse-forming network with a 25-turn 0.1% helipot to determine the pulse height. The characteristics of the amplifier include a gain of 4,800, rise time of >35 μsec, input impedance of 8k, negative input polarity, and linearity of <0.25 V to 100 V. The first loop of the amplifier is a current feedback circuit that inverts the pulse

and has a gain of ~50. The second loop of the amplifier is a non-inverting voltage-feedback circuit with a gain of ~100. A short time constant is necessary to reduce the ripple and base-line shift. A cathode follower is employed to drive the discriminator and provide a monitor for the amplifier. In the window-type discriminators, which are used, the upper discriminator tracks the lower discriminator with the differential between them set by the window control. (For details see TID-4100 Suppl. 59) (F.S.)

41662 DETERMINATION OF THE EFFICIENCY OF REGISTRATION OF GAMMA-RADIATION BY NaI(Tl) CRYSTALS BY THE MONTE-CARLO METHOD. Belov, O. Kh.; Bartanov, N. A.; Samoylov, P. S. Tr. Soyuznogo Nauch.-Issled. Inst. Priborostr.; No. 10, 3-11(1969). (In Russian).

The Monte Carlo Method is used for determining the efficiency of registration of gamma-quanta by NaI(Tl) crystals. The efficiency of registration η is defined as the ratio of the number of gamma-quanta which undergo at least one interaction in the crystal to the total number of gamma-quanta passing through the surface of the crystal. The source is located on the extended axis of the crystal at a distance h from the surface. Tables of values η are given for standard NaI(Tl) crystals measuring 40 × 40, 63 × 63, and 150 × 100 mm; E_γ = 0.1 to 10 MeV, h = 0 to 20 cm. Some of the tabulated data are reproduced graphically. The values of η fall monotonically up to $E_\gamma \approx 5$ MeV; in the 5 to 10 MeV region a considerable increase in η is observed due to a rise in the contribution of the pair production cross section to the total cross section of the interaction. In the region of h from 0 to ≈ 4 cm the values of η fall off. With a further increase in h, the values of η rise, reaching a maximum at h = ∞. This dependence of η on h is due to the change in the mean free path of gamma-quanta in the crystal with a change in the distance between the source and the crystal surface. (JPRS)

41663 TEMPERATURE GRADIENT MEASUREMENTS IN THE DIFFUSION CLOUD CHAMBER WITH THE USE OF THERMISTORS. Chrapan, J.; Ruzicka, J. (Komensky Univ., Bratislava). Jad. Energ.; 16: 98-9(1970). (In Czech).

Temperature gradients in one vertical and three horizontal layers have been measured in the Cowan's diffusion cloud chamber. Temperature measurements have been made with a thermistor. The measurement accuracy was dependent on the thermistor calibration accuracy and on the precision of the resistance measurement. The shape of the measured curves of the dependence of temperature on the position has been in good agreement with the theoretical curves. (auth)

41664 FORWARD AND REVERSE CHARACTERISTICS OF A SILICON BARRIER DETECTOR WORKING IN THE AVALANCHE REGION. Peyre-Lavigne, Andre (Toulouse Univ.); Francois, Henri. Compt. Rend., Ser. B; 270: 1630-2(22 Jun 1970). (In French).

Surface barrier detectors (metal-semiconductor) operating in the avalanche region are discussed. The forward and reverse characteristics and the value of the multiplication coefficient are given. (France)

41665 SOLID TRACK DETECTORS. Blanc, D. (Toulouse Univ.). Radioprotection; 5: 37-78(1970). (In French).

The text is the beginning of a course which will be continued in the next numbers of the journal. It includes a study of the latent track and development and properties of the particle track. (France)

41666 RADIATION ACTION ON PHOTOGRAPHIC EMULSIONS. Sultan, Jacques (Societe Kodak-Pathe, Paris). Nucleus (Paris); 11: 1-18(1970). (In French).

Radiation detection with photographic emulsions results from the ionization occurring in the silver halide crystals of the emulsion. These ionization phenomena are the basis of the latent image. The case of charged particles (electrons, alpha particles) which produce direct ionization is discussed, and also that of neutral particles (photons and neutrons) which produce indirect ionization through the charged particles they set in motion in the emulsion. The complex action of the x and gamma ray photons and of the particles on the photographic layers (primary interactions followed by secondary and tertiary interactions, etc.) are recalled. The case is examined in which the low energy of the electrons obtained at the end of the cascade (neutron detection) requires the use of re-enforcing screens or of image intensification using thermoluminescent techniques. (France)

41667 SIMPLE CHEAP CONTINUOUS FLUX MONITOR FOR 14-MeV NEUTRONS. Mathew, P. J.; Pohl, K. P. (Inst. of Nuclear Sciences, Lower Hutt, N. Z.). Anal. Chim. Acta; 51: 336-8(Aug 1970).

... gas neutron flux monitor, based on the activation reaction $^{16}O(n,p)^{16}N$ in the target cooling water, is briefly described. The activated ^{16}N beta decays to excited states of ^{16}O which decay to the ground state emitting 6.1 and 7.1 MeV gamma rays. A scintillation detector is used. Results of measurements are compared with results using aluminum activation foils and boron trifluoride proportional detectors. (W.H.K.)

41668 REMOTE CONTROL OF THE AUTOMATIC 35 MM FILM CAMERA ON THE NUCLEAR CHICAGO GAMMA CAMERA. Prince, John R.; Dukstein, Walter G.; Arnold, James S. (Kansas City General Hospital, Mo. Univ. of Missouri, Kansas City). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 833-4(Aug 1970).

A method for remote control of the automatic 35 mm film camera on the Nuclear Chicago Gamma camera is presented. The components and the wiring schematics for this type of remote control are discussed. (auth)

41669 TRACK ETCHING PARAMETERS FOR PLASTICS. Blanford, G. E. Jr.; Walker, R. M.; Wefel, J. P. (Washington Univ., St. Louis). Contracts Z-80058T; NAS 9-8352. Radiat. Eff.; 3: 267-70(Jun 1970).

A series of experiments was performed to study the effect of types of etchant, concentration of etchant, etchant temperature, and other parameters on track development in cellulose nitrate, polycarbonate resin, cellulose triacetate, and cellulose acetate butyrate plastic. This work has led to a set of preferred etching conditions for each of these plastics. For example, although there were only slight differences in general etching rate when LiOH, KOH, and NaOH were used as track etchants for cellulose nitrate, the alpha particle registration sensitivity was greatest when NaOH was used. Also in cellulose nitrate the general etching rate and the particle registration sensitivity did not change significantly with increasing concentration for hydroxide solutions >6 N. This was in marked contrast to other plastics which showed a strong concentration dependence. (auth)

41670 THE DIAMETER OF ETCHED FISSION-FRAGMENT TRACKS IN SOLID-STATE NUCLEAR TRACK DETECTORS AS A FUNCTION OF THE PARTICLE ENERGY. Fiedler, G.; Hoeppner, U. (Univ., Giessen, Ger.). Radiat. Eff.; 3: 271-3(Jun 1970).

Fission fragments with known mass and energy were separated and used to bombard glass. After etching in 48% HF at room temperature, the resulting mean etch pit diameter was plotted as a function of energy for various etching times. For long etching times (50 to 100 sec), the diameter increases with energy above 40 MeV with constant slope; an energy resolution of 3 to 5 MeV is possible between 15 and 80 MeV. The effect of heavy and light fragments is relatively small. This method was tested by measuring the energy distribution of ^{252}Cf-spontaneous fission fragments. (D.L.C.)

41671 ENVIRONMENTAL NEUTRON MEASUREMENTS WITH SOLID-STATE TRACK RECORDERS. Roberts, J. H. (Northwestern Univ., Evanston, Ill.); Parker, R. A.; Congel, F. J.; Kastner, J.; Oltman, B. G. Radiat. Eff.; 3: 283-5(Jun 1970).

The suitability of using ^{10}B and ^{6}LiF in contact with cellulose acetate butyrate (CAB) for the measurement of slow neutron densities has been investigated. The upper energy threshold of clear Diacel cellulose nitrate (CN) and of the CAB have also been measured. The CAB in good contact with thick ^{10}B or ^{6}LiF sources offers good promise for the detection of slow neutrons. For the actual CAB samples used, the CAB-^{10}B combination had an efficiency of $\sim 1.3 \times 10^{-2}$ tracks per thermal neutron incident in a 2π solid angle. The corresponding number for the CAB-^{6}Li combination is $\sim 5.6 \times 10^{-3}$ tracks per thermal neutron. (auth)

41672 STUDIES OF ENVIRONMENTAL EFFECTS ON TRACK-ETCHING RATES IN CHARGED PARTICLE-IRRADIATED POLYCARBONATE FILM. DeSorbo, W.; Humphrey, J. S. Jr. (General Electric Research and Development Center, Schenectady, N. Y.). Radiat. Eff.; 3: 281-2(Jun 1970).

An investigation was made of combined uv-gas environmental effects on the track etchability of Makrofol polycarbonate tape exposed to fission fragments from ^{252}Cf. It was found that 3-min uv exposures in conjunction with N_2O increases the time to first pore breakthrough, while if O_2 or NO is used, the breakthrough time is reduced. The wavelength dependence of the uv-O_2 effect was studied; the breakthrough time increases in going from 304 to 366 nm. (D.L.C.)

41673 DEVELOPMENT OF TRACKS WITH SOLVENTS. Sanzelle, S.; Monnin, M. (Univ., Clermont-Ferrand, France). Radiat. Eff.; 3: 279-80(Jun 1970). (In French).

Some tracks are obtained in several plastics using an organic solvent track etching procedure. The described results are those

obtained with ethyl alcohol. The samples (PMMA) are submitted to pure alcohol, then to water. In this way, one can get 6 MeV α-tracks but the phenomenon is not reproducible. The most frequent observations are described. (auth)

41674 STUDY OF THE STRUCTURE OF HEAVY-ION TRACKS IN NITROCELLULOSE BY ELECTRON MICROSCOPY. Tripier, J.; Debeauvais, M.; Stein, R.; Ralarosy, J.; Remy, G. (Laboratoire de Physique Corpusculaire, Strasbourg-Cronenbourg). Radiat. Eff.; 3: 221-6(Jun 1970). (In French).

Electron microscope observations of heavy ion tracks registered in thin nitrocellulose foils and visualized by chemical etching lead to the following conclusions: (1) The revealing time of the tracks is a decreasing function of the energy loss (dE/dx) and the development velocity is an increasing function of (dE/dx). (2) The track structure depends on the variation of dE/dx along the ion path. (3) The etching rate inherent to the development seems to increase disparities in the initial structure. To perform a more careful study, thin foils were irradiated with sulphur ions at energies between 0 and 80 MeV. The diameter change was plotted against the energy loss (dE/dx) of the ion, the chemical reagent concentration, and the development time. In this way, an empirical law depending on those different parameters has been deduced. (auth)

41675 MICA TARGETS WITH A NEARLY 4π GEOMETRY FOR FISSION STUDIES. Boos, A. H.; Brandt, R.; Starke, K. (Phillipps-Univ., Marburg, Ger.). Radiat. Eff.; 3: 235-8 (Jun 1970).

Mica was bombarded with fission products from ^{252}Cf. After etching the holes were filled with uranium, the mica now serving as a detector with a nearly 4π geometry. Qualitative results of irradiations with 0.6- and 20-GeV protons are given to demonstrate the usefulness of this technique. (auth)

41676 USE OF A PULSE DETECTOR FOR REACTOR NOISE MEASUREMENTS. Trinko, J. R. Jr. (Univ. of Tennessee, Knoxville); Hanauer, S. H.; Roux, D. P.; De Lorenzo, J. T. Nucl. Appl. Technol.; 8: 522-30(Jun 1970).

A pulse-mode neutron detection system designed for reactor noise measurements was characterized and compared with conventional current-mode noise measurement systems. Pulses from a boron-10-lined proportional counter with a 60 nanosec electron collection time were amplified and applied to a discriminator and thence to a counting-rate circuit with a time constant of 15 μsec. Statistical fluctuations in the counting-rate voltage were frequency analyzed. Under conditions of negligible gamma flux and counting loss, the pulse system yielded frequency spectra indistinguishable from ion-chamber spectra. The results were not very sensitive to counting loss up to at least 20%, but the effect of counting loss limited the ultimate useful neutron flux for the system tested to less than 2×10^6 nv. Space charge and gamma pileup in the detector controlled the performance of the pulse system in high gamma fluxes; the pulse system performed better than the best available current system over a limited range of neutron and gamma flux intensities. Because of its shorter time constant, the pulse-mode system can be used to measure power spectral density at much higher frequencies than the current-mode system. Thus the pulse-mode system appears to be the more attractive for fast reactor subcriticality measurements. (auth)

41677 EFFECT OF LATENT IMAGE INSTABILITY ON QUANTITATIVE RADIOAUTOGRAPHY. Kraus, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Isotopenpraxis; 6: 154-6(Apr 1970). (In German).

Film density as a function of time between exposure and development using various developers with stripping film ORWO K 105 is presented graphically. Also, data are presented on film density for films stored at different temperatures and for films stored with and without drying agents in the exposure box. (W.H.K.)

41678 MEASUREMENT OF DE-EXCITATION TIME OF SCINTILLATORS IN NANOSECOND REGION. Smelcerovic, M.; Cirilov, B. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Isotopenpraxis; 6: 147-50(Apr 1970).

A method of de-excitation time measurement of scintillators by a cathode-ray oscillograph is described. By approximation of the filter network of the oscillograph amplifier with one or more integration constants, the corresponding equations have been obtained. Showing them graphically, there is a possibility for a fast determination of the de-excitation time of the exmauned substances. Moreover, there is a possibility for the measurement of amplitude yield of the slow-dexcitation component with regard to the fast one by a direct analysis of the recorded oscillogram. (auth)

41679 SYSTEM FOR TAKING BETA-GAMMA RADIO AUTOGRAPHS. Nauche, Roger; Planson, Jean (to European Atomic Energy Community). British Patent 1,196,190. 24 Jun 1970. Priority date 21 Aug 1967, Belgium.

Apparatus is described for $\beta-\gamma$ radioautography with means to prevent fogging of the film by α radiation. The apparatus is designed to be used with an enclosure such as a glove box. A support member including a throughway or hole provides a socket to receive the sample to be studied. The throughway is open at one end for insertion of the sample and is closed at the other end by a closure member that is opaque to α radiation. A sensitive photographic plate, film, or sheet for receiving and recording the radiation passing through the closure member from the sample is supported near the socket. A glove or sleeve is sealed across an acess opening in the wall of a glove box or hot cell. (B.L.M.)

41680 MONITOR WITH A RESTRAINING UNIT FOR DETERMINING RADIOIODINE ACTIVITY IN CANINE THYROID GLANDS. Foreman, Robert E.; Goodrich, Richard M.; Boecker, Bruce B. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Amer. J. Vet. Res.; 31: 1303-7(Jul 1970).

The design, construction, and use of an external canine thyroid gland monitor for either iodine metabolism studies or clinical diagnostic procedures are described. A NaI crystal (5.1 cm in diameter by 5.1 cm thick) housed in a cylindrical lead shield was used as the detector unit. Distance between thyroid gland and crystal could be varied by moving the crystal vertically within the shield while the neck of the dog was maintained in contact with the top of the shield. The dog was restrained during the counting interval in an adjustable sling device. This unit, although simple in design, performed consistently and accurately in a study of the effects of age and route of administration on ^{131}I metabolism in the Beagle dog. (auth)

41681 LUMINESCENCE OF GASES INDUCED BY NUCLEAR PARTICLES. Blanc, Daniel (Toulouse Univ.); Brunet, Henri; Galy, Jacques; Teyssier, Jean-Louis. Nucleus (Paris); 11: 47-51 (1970). (In French).

After indicating the main characteristics of gas scintillators, which are no longer used except in neutron detection or fission fragment detection experiments, a description is given of the analytical methods used to study the fundamental phenomena occurring during the luminescence of alpha particle-irradiated gases (plotting of optical spectra, measurement of luminescence decay time constants). The main results obtained with argon are presented. The action of an electric field has a reenforcing effect on the scintillation and the practical and theoretical implications of this are examined. A short review of the recent work dealing with the luminescence of air and its components is included. (France)

41682 SCANNING DEVICE FOR THE PLAN REPRESENTATION OF RADIATIONS EMITTED BY AN OBJECT. Desgrez, Alex (Commissariat a l'Energie Atomique). British Patent 1,196,330. 24 Jun 1970. Priority date 5 Oct 1966, France.

The scanning device described for the plan representation of radiations emitted by an object is intended for the preparation of cartograms, which are characteristic of a radioactive tracer in an organ of the human body or a phantom. Pulses delivered by a radiation detector are transmitted through a frequency divider on one hand to an element that controls a source of light flashes at a frequency proportional to the intensity of the detected radiation and on the other hand to a counter that receives the pulses of a time base, i.e., a timer producing pulses at regular time intervals, and control means for color selection and synchronization of the emission of a light flash with the passage of a selected colored filter in front of the source. The counter is made up of a number of bistable multivibrators in which are decoded a number of stages equal to the number of colored filters. The stages are distributed so as to obtain a division of the complete range of count rates according to a predetermined law. (B.L.M.)

41683 METAL INSULATOR SEMICONDUCTOR RADIATION DETECTOR. Phelan, Robert J. Jr.; Dimmock, John O. (to Massachusetts Inst. of Tech.). U. S. Patent 3,497,698. 24 Feb 1970. Filed 12 Jan 1968.

A photodiode is formed by a structure consisting of an insulating layer on the surface of a semiconductor and a metal film on the surface of the insulator. Starting with a semiconductor of given conductivity type, a high electric field is produced in the semiconductor in a region immediately adjacent to the insulator to form a p-n-like semiconductor junction. In one embodiment, the thickness of the insulating layer is determined to provide a capacitance in series with the p-n-like junction, which is substantially greater than the intrinsic shunt capacitance of the junction, so that when the structure is energized with electrical

or optical pulses, the junction shunt capacitance charges during the interval of a pulse, but the series capacitance does not and so a strong photovoltaic response to selected radiation incident on the p-n junction is exhibited. (Offic. Gaz.)

41684 IMAGE INTENSIFICATION TUBES FOR GAMMA RADIATION. (to Picker Corp.). British Patent 1,201,001. 5 Aug 1970. Priority date 30 Jan 1967, United States.

An image intensification tube for γ radiation comprises an evacuated envelope containing adjacent to the input end a dish-shaped substantially crystalline sheet of photoluminescent material serving as a light emissive layer for emitting photons in response to stimulation by γ radiation. The envelope also contains a dish-shaped electron emissive layer for emitting electrons in response to stimulation by the photons and means for accelerating the electrons against an output phosphor. The photon emitting layer is preferably a single crystal of CsI. (B.L.M.)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 41190.

41685 (NP-18359) SPECTRAL MEASUREMENTS ON RADIOACTIVE NEUTRON SOURCES IN THE ENERGY RANGE OF 10 keV TO 10 MeV WITH PROTON RECOIL PROPORTIONAL COUNTERS. Werle, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Feb 1970. 107p. (In German). (INR-4/70-25). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Karlsruhe, Ger.

Proton recoil proportional counters have been used for neutron spectrum measurements in the energy range between about 20 keV and 1.5 MeV. It is shown by measurements with monoenergetic neutrons and by comparison measurements with other methods, that with proton recoil counters, reliable measurements are also possible below 20 keV and in the energy range between 1.5 and 10 MeV. The spectra of most of the normally used, radioactive neutron sources (α,n-sources: Ra-Be, Am-Be, Am-B, Am-^{10}B, Am-F, Am-Li; ^{252}Cf spontaneous-fission source) were measured in the whole interesting energy range, especially also in the range below 1 to 2 MeV. The influence of the size of the radioactive particles on the neutron spectrum was studied. The differential neutron spectrum of a Sb-Be (γ,n)-source can be determined for the first time with good accuracy, in spite of the very high γ-background, by using the γ-n discrimination technique. (auth)

41686 (UCRL-19903) A COMPUTER PROGRAM FOR THE SMOOTHING AND DIFFERENTIATION OF DATA FROM MULTICHANNEL ANALYZERS. Gorman, D. J. (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1970. Contract W-7405-eng-48. 39p. Dep. CFSTI.

In the interpretation of spectra taken on multichannel analyzers it is frequently helpful, especially in cases where the statistics are poor, to smooth the data in order to reduce the statistical fluctuations. When presented with such a spectrum one would normally draw through the points a smooth curve which best fits them. This can be done numerically once we define what we mean by best fit. The most common criterion is to minimize the sum of the squares of the residuals between the actual and fitted points. This method has been described by Savitzky and Golay who fit a polynominal over a range of (2m + 1) data points and use that to evaluate the smoothed value at the mid-point. The data points taken are then shifted by one, dropping the point at the left and picking up one at the right. This process is repeated to cover the entire spectrum. Upon doing one least squares analysis one obtains a set of coefficients, one for each point over which the fit is performed. The value at the mid-point of one interval of 2m + 1 points is found by summing the products of the counts in each channel and the particular coefficient for that channel. The main part of the least squares analysis of Savitzky and Golay are reproduced here along with some corrections and additions. Also, a computer program to calculate convolution factors using this least squares procedure is presented. (auth)

41687 HELIUM-FILLED STREAMER CHAMBER FOR EXPERIMENTS IN NUCLEAR PHYSICS. Busso, L.; Costa, S.; Ferrero, L.; Garfagnini, R.; Pasqualini, L.; Piragino, G. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 104: 423-35 (May-Jun 1970).

The high-voltage pulse generator and the triggering system for a helium-filled streamer chamber for low and intermediate energy nuclear physics experiments are described. Various experiments with the streamer chamber are discussed. (W.H.K.)

41688 AUTOMATIZED CURVED CRYSTAL SPECTROMETER FOR (n,γ) MEASUREMENTS AT RISOE. Koch, H. R.; Baader, H.; Breitig, D.; Gruber, U.; Maier, B. P. K.; Schult, O. W. B. (Technical Univ., Munich. Research Establishment, Risoe, Denmark). pp 144 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25-30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).

See CONF-690804.

41689 APPLICATION OF SOLID-STATE TRACK RECORDERS FOR NEUTRON SPECTRA MEASUREMENTS IN A REACTOR IRRADIATION FACILITY. Koehler, W. (International Atomic Energy Agency, Vienna). Radiat. Eff.; 3: 231-3(Jun 1970).

In connection with the IAEA-neutron seed irradiation programme, a standard neutron irradiation facility has been constructed. The application of solid state track recorders for fast neutron spectra measurements inside this facility is discussed. Fissionable targets of ^{235}U, ^{239}Pu, ^{237}Np, ^{238}U, and ^{232}Th will be used, and an approximative solution for the incident neutron spectrum will be obtained by a five-group method. (auth)

41690 RAPID ACQUISITION AND ANALYSIS OF GAMMA-SPECTROMETER DATA USING A SMALL COMPUTER. Sax, N. I.; Daly, J. C. (New York State Dept. of Health, Albany). Nucl. Appl. Technol.; 8: 516-21(Jun 1970).

A processor-oriented gamma spectrometer system for the rapid and efficient acquisition of radiological data is described. Gamma spectral data are accumulated and operated upon in the same unit to arrive at activity levels for the gamma emitting radionuclides in the sample. A comparison is made between the operational aspects of the conventional hard-wired analyzer and the processor-oriented system. It is shown that this type of system provides increased flexibility as well as more rapid processing and reporting of data. (auth)

High Energy Physics Instrumentation

41691 (COO-1195-192) THE DOLLY FILM MEASURING SYSTEM. Downing, R. W.; Brown, R. M.; Simaitis, V. J.; Wray, J. J.; Zander, D. R. (Illinois Univ., Urbana. Dept. of Physics). Jun 1970. 3p. (CONF-700902-1). Dep. CFSTI.

From International Conference on Instrumentation for High Energy Physics, Dubna, USSR.

DOLLY, a precision film measuring machine for bubble chamber and spark chamber film, is briefly described. Film transport and optics, operator controls, CRT scanner, and data processing are discussed. (W.H.K.)

41692 (SLAC-Trans-121) BUILDUP OF GAS DISCHARGES IN THE PROPORTIONAL AND GEIGER REGION FOR USE IN CHARPAK CHAMBERS. Stuckenberg, H.-J. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Translated by R. Addis for Stanford Linear Accelerator Center, Calif., from report DESY-69/49. 33p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 19197.

41693 BUBBLE CHAMBERS. Bullock, F. W. (University Coll., London). Sci. Progr. (Oxford); 58: 301-27(Autumn 1970).

The current state of bubble chamber techniques and prospects for the future are reviewed under the following headings: the use of bubble chambers in elementary particle physics, the original work of Glaser (1951 and 1952), constructional and operational features of a modern bubble chamber (including achievement of the superheated state, constructional difficulties due to the pressure, the magnet, the temperature problem, illumination, photography and optics), the physics of bubble formation and growth, methods of particle identification, accuracy of positional and angular measurements, choice of working liquid and its effects on chamber design, the analysis of bubble chamber pictures, and the future. (UK)

41694 METHOD OF MAKING AN OMEGA-SHAPED ANNULUS. Genens, Lyle E.; Kleb, Robert (to United States Atomic Energy Commission). U. S. Patent 3, 518,861. 7 Jul 1970. Filed 26 Jul 1968.

An omega-shaped annulus is formed from a short tube of large diameter by alternate steps of expanding the tube by pressure fluid and of shortening the tube with the fluid at zero pressure. The apparatus for shortening the tube is of moderate size, because the pressure fluid is at zero pressure during the shortening steps. (Offic. Gaz.)

Radiation Dosimeters

Refer also to abstracts 41366, 41713, and 41876.

41695 (COO-1105-160) THERMOLUMINESCENCE IN CaF_2:nat AS A DOSIMETER FOR THE TERRESTRIAL SOLAR ULTRAVIOLET RADIATION ENVIRONMENT. McCullough, Edwin C.; Cameron, John R. (Wisconsin Univ., Madison. Dept. of Radiology). [1968]. 14p. Dep. CFSTI.

Results of tests on natural calcium fluoride thermoluminescent dosimeters for dosimetry of terrestrial ultraviolet radiation are presented and discussed. Sensitivity, stability, linearity and other properties were studied. (W.H.K.)

41696 (DUN-7027) SELECTABLE LEVEL ALARMING PERSONAL DOSIMETER. Erickson, G. L. (Douglas United Nuclear, Inc., Richland, Wash.). 4 Jun 1970. 14p. Dep. CFSTI.

Pocket type personal dosimeters with five selectable dose alarm points have been developed and are being field tested at Hanford. Pulses from gamma energy corrected GM tubes are integrated by low power digital integrated circuits to produce an audible alarm at logic levels corresponding to the integrated dose levels. Dose integrating precision of $\pm 1/2\%$ is achieved for dose rates less than 20 R/hr. Accumulated dose can be retained in memory in excess of 1000 hours and read out by an auxiliary module when required. The annunciator provides an easily distinguished warbling tone (110 db at 1 inch) when a pre-selected dose has been exceeded and a short "beep" every time 1.5 mR is accumulated. A high dose rate annunciation (20 R/hr and higher) and a complete self test circuit is included in the design. The dosimeter is packaged in a $1'' \times 2.2'' \times 4.8''$ and has an operating weight of 6.35 ounces. The average operating life with a standard zinc carbon 9 volt battery is in excess of 500 hours. The dosimeter is designed to operate over a wide range of temperature and humidity and can withstand considerable physical abuse. (auth)

41697 (HASL-233) TESTS OF TLD-700 HIGH SENSITIVITY LiF RIBBON FOR LOW-LEVEL ENVIRONMENTAL RADIATION MEASUREMENTS. Shambon, Arthur; Freeswick, Donald C. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Jul 1970. 15p. Dep. CFSTI.

A technique for measurement of gamma dose down to 1.5 mR with a standard deviation of 10% for individual dosimeters is described. Lithium fluoride thermoluminescent ribbons are used with an improved readout system called the HASL luminescence emission monitor (LEM). The LEM employs nitrogen gas heating and an ellipsoidal reflector for light collection. Sensitivity data are presented. (W.H.K.)

41698 CALIBRATION OF DOSIMETERS FOR RADIATION THERAPY AND RADIATION PROTECTION. Huebner, W. PTB Mitt.; 80: 186-9(Jun 1970). (In German).

Starting from the experiences of the voluntary calibration of dosimeters for radiation therapy and radiation protection, some questions are discussed dealing with problems of organization, finances, personnel, and technology. These problems will arise for the governmental authority if the calibration of dosemeters will become obligatory by law. (auth)

41699 CALORIMETER FOR THE DETERMINATION OF ABSORBED DOSE IN AQUEOUS (TISSUE EQUIVALENT) MEDIA. Wojtech, Leonard; Heuss, Kurt (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Biophysik; 6: 345-56(1970). (In German).

A calorimeter has been developed for the determination of the absorbed dose rate in an aqueous (tissue equivalent) medium. An aqueous dilute solution of an electrolyte (0.02 N NaCl) was used simultaneously as absorbing and measuring system. The absorption of the radiation energy leads to a rise of temperature in the solution. This rise was measured via the increase of the electrical conductivity, which takes place in an electrolytic solution on warming. For this purpose an ac bridge (impedance comparator) and a measuring cell of glass were used. At the site of radiation entrance and exit the solution was bounded by 150 μm polyethylene foils. Calibration was done by electrical heating. The dose rate has been determined without using the value of the temperature coefficient of the electrical conductivity. The method was demonstrated on a 240 kW-X-ray tube with an effective photon energy of 22 keV and dose rates of 500 rd/s and more. Furthermore measurements of radiochemical yields were performed. (auth)

41700 EXPERIMENTAL TECHNIQUE OF MEASUREMENT OF MICROSCOPIC ENERGY DISTRIBUTION IN IRRADIATED MATTER USING ROSSI COUNTERS. Srdoc, Dusan (Columbia Univ., New York). Contract AT(30-1)-2740. Radiat. Res.; 43: 302-19(Aug 1970).

An experimental method for measuring the distribution of energies deposited in small tissue-equivalent volumes is described. The energy deposited in a cavity is measured by means of a proportional counter. The counter geometry and the associated electronics as well as properties of tissue-equivalent gases are discussed in detail. A calibration technique using soft x-rays generated by a miniature x-ray tube is described. Several relations are derived which help to determine limits of an experimental arrangement in terms of simulated tissue volumes. Examples of distribution of energies deposited by ^{60}Co gamma rays in tissue spheres of 0.5, 1, and 2 μm in diameter are given. (auth)

41701 MEASURING INSTRUMENT FOR THERMO-LUMINESCENT DOSIMETERS. (Manufacture Belge de Lamps et de Material Electronique SA en Abiege MBLE). British Patent 1,190,483. 6 May 1970. Priority date 22 Feb 1967, Netherlands.

An instrument is provided for measuring the quantity of light emanating from the radiation-sensitive element of a dosimeter upon heating it. The temperature to which the dosimeter must be heated to release the entire store of radiation is controlled by interrupting the current to an electrical resistance heater at a predetermined temperature by comparing a signal depending upon the resistance of the heating element with a reference signal and using the difference between the signals to actuate the interruption of the current. (B.L.M.)

Radiometric Instruments

41702 (NP-tr-1917) FUNCTIONING OF A RADIOMETRIC BELT WEIGHTOMETER; EXPERIENCE IN ITS DESIGN AND TESTING. Krueger, G. Translated by D. H. Garrett (Victorian State Electricity Commission, Melbourne, Australia), from Bergakademie; 21: 346-50(Jun 1969). 13p. Dep. CFSTI (U. S. Sales Only).

A weighing apparatus for use with belt conveyors is described. It is based on the absorption of radiation by the transported material, and functions without contacts. A cesium-137 source and ionization detector were used. Measurement error was <1%. An outline of the theoretical and experimental studies of the optimum placing of the emitter and detector system and a description of a full-scale installation with initial operating tests, are given. Advantages of this type of weightometer are discussed. (Australia)

41703 RELATIONSHIP BETWEEN GAMMA RAY TRANSMISSION AND CLEAN WOOL FIBER DIAMETER. Mohiuddin, M. (Alberto-Culver and Co., Chicago). Indian Vet. J.; 47: 236-44(Mar 1970).

Fifteen different lots of scoured wool were passed through γ radiation of primary energy, 660,000 electron volts. Transmission count rates were obtained on each lot of wool, with three readings at three equi-distant positions. The results of the count rates of γ-ray transmission indicated significant differences ($P < .01$) between the 15 lots of scoured wool and between clean wool from five different growers. Also, differences in the count rates of γ-ray transmission between positions were significant ($P < .05$). The lots of clean wool, after irradiation, were analyzed for fiber thickness. The mean fiber diameter of clean wool from different growers differed significantly ($P < .01$). The finer wool clips showed a tendency to block the γ-ray transmission more than the coarser ones. The data on fiber thickness was correlated with the γ-ray transmission rate. The correlation of these variables gave a value of $r = 0.518$, which was significant ($P < .05$), indicating that the thicker the mean diameter of scoured wool, the greater the γ-ray transmission rate. The results of this study indicate a possible use of γ radiation for assessing the clean wool fiber diameter. (auth)

41704 PENETRATING RADIATION SYSTEM FOR DETECTING THE AMOUNT OF LIQUID IN A TANK. Kaminskas, Rimvydas A.; Wright, Donald E. (to National Aeronautics and Space Administration). U. S. Patent 3,501,632. 17 Mar 1970. Filed 4 Jun 1964.

A penetrating radiation system is described for measuring the amount of liquids within a definite region regardless of whether the shape of the container or whether the contents are in motion. Both the extended source and detector systems are so arranged with respect to the region in question that the effective absorption produced by the matter in the region is substantially independent of the configuration of the matter. (B.L.M.)

41705 ANALYSIS OF RADIOISOTOPE THICKNESS GAUGE AS A REGULATION SYSTEM SUBASSEMBLY. Dimic, M.; Mikic, R.; Nikolic, M.; Herman, D.; Stanojevic, I. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). Isotopenpraxis; 6: 150-4(Apr 1970).

The radioisotope thickness gauge developed at "Boris Kidrich"

Institute of Nuclear Sciences-Vinča is applied in industrial plants as a sensing device of the thickness regulation system. An analysis of transfer functions of the thickness gauge IMD-4 modified to fit the system for copper strips cold rolling process control in the thickness range of 0.1...3 mm is given. (auth)

41706 IMPROVEMENTS IN OR RELATING TO DEVICES FOR MEASURING THE MOISTURE CONTENT OF A VOLUME OF MATERIAL. (to Electricite de France Service National). British Patent 1,193,003. 28 May 1970. Priority date 23 Mar 1967, France.

A modification of an apparatus for determination of moisture content and density of a material described in patent No. 1,125,017 is described. Sources of γ radiation and neutrons are disposed on one side of a volume of the material. Detectors for γ radiation and for neutrons that are of an energy greater than scattered neutrons are disposed on the other side of the material. The detection means are separate detectors contained within a scattering and slowing-down medium surrounded, at least in the direction of the incident radiations that have been transmitted through or scattered by the material, by a shield for absorbing neutrons having energies below a predetermined threshold. The slowing-down medium is a solid, such as paraffin wax, containing a high proportion of hydrogen. (B.L.M.)

41707 RADIOISOTOPE NEUTRON ACTIVATION ANALYZER FOR PROCESS CONTROL ANALYSIS. Kuusi, Juhani (Technical Univ. of Helsinki, Otaniemi, Finland). Nucl. Appl. Technol.; 8: 465-73(May 1970).

A neutron activation analyzer utilizing an isotopic neutron source is described. The analyzer has been installed at a chrome concentration plant for off-line process control. Silicon, chromium and aluminum can be simultaneously determined in chrome concentrates, ore samples, etc. Results obtained are described and further applications of the activation analyzer of this type in the glass, ceramic and cement industry are discussed. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 41516, 41701, 41727, 42065, 43609, and 43699.

41708 (IS-2335) PHOTON MONOCHROMATOR USING COMPTON-SCATTERED GAMMA RAYS. Hall, J. E.; Struss, R. G.; Zaffarano, D. J. (Ames Lab., Iowa). Jul 1970. Contract W-7405-eng-82. 55p. Dep. CFSTI.

A facility has been developed which uses Compton-scattered gamma rays as a variable energy source for photonuclear experiments below 8.2 MeV. A collimated beam of neutron-capture gamma rays of maximum energy 8996 keV is produced by positioning a 1 kg plate of nickel in the tangential tube of the Ames Laboratory Research Reactor. The energy of these gamma rays is varied by Compton scattering from a curved plate. The shape of the plate was chosen to ensure that it would bend into the arc of a circle under columnar loading. In order to ensure that the (n,γ) source, the scattering plate, and the photonuclear target all lie on the same arc of a circle for each scattering angle, the curvature of the scattering plate was made easily variable. The "efficiency" of various materials for use as the scattering plate has been calculated. Characteristics of the scattered gamma ray beam at the target position are presented for the case of an aluminum scattering plate. The intensity of the scattered 8996 keV line incident on the target (2.00 × 0.75 in.) is 10^5 per sec at a scattering angle of 13.45 degrees (6067 keV). (auth)

41709 (LMEC-70-8) CHARACTERISTICS OF LMEC ELECTRICAL RESISTANCE STRAIN GAGES UTILIZING ARMOUR D ALLOY. Lemcoe, M. M. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). 30 Jun 1970. Contract AT(04-3)-700. 107p. Dep. CFSTI.

Results of a development and evaluation study are presented for several high-temperature strain gage configurations which use Armour D alloy (^{70}Fe–^{20}Cr–^{10}Al) as the primary element, and platinum as a temperature-compensating element in the composite gage configurations for use in the LMFBR program. The Armour D gage concepts appear promising for applications up to 1200°F; particularly when used on austenitic stainless-steel components. (auth)

41710 (ORO-3106-33) SPC-12 MASS SPECTROMETER ROUTINES: REAL TIME DATA ACQUISITION AND DATA REDUCTION FOR BENDIX T-O-F INSTRUMENTS. Fallgatter, M. B.; Hanrahan, R. J. (Florida Univ., Gainesville). Mar 1970. Contract AT(40-1)-3106. 21p. Dep. CFSTI.

A General Automation SPC-12 computer-based data acquisition and reduction system for a Bendix model 14 time-of-flight mass spectrometer for routine analysis of chemical products resulting from gamma radiolysis of organic compounds and related research is described. (W.H.K.)

41711 (UCRL-50892(Vol.3)) WEAPONS EFFECTS DISPLAY SYSTEM (WEDS MOD II): ROM ACCESSORY USER'S MANUAL. Peschel, D. J. (California Univ., Livermore. Lawrence Radiation Lab.). 10 Jun 1970. 35p. Dep. CFSTI.

When the ROM accessory package is used, the Weapon Effects Display System (WEDS MOD II) can display classified prompt effects data for nuclear weapons. The ROM is a read-only-memory that contains coefficients used in the computer program to generate the effects data; it is a small, hand-held package that is manually inserted into and removed from the WEDS MOD II console. This manual describes the installation, theory of operation, data loading procedures, and maintenance testing procedures for ROM. The electronic circuit data are also given. (auth)

41712 DATA PROCESSING SYSTEM FOR RADIOACTIVITY MEASUREMENTS ON AIR SAMPLES. Stevens, D. C.; Churchill, W. L.; Fox, D.; Large, N. R. (Atomic Energy Research Establishment, Harwell, Eng.). Ann. Occup. Hyg.; 13: 177-85(Jul 1970).

A data processing system is outlined for the computation and filing of radioactivity measurements on air samples, operating on an IBM 360/65 computer. Input data are supplied in coded form on cards and the output is a decoded printed list giving sample details and the concentration of radioactive aerosols. Punched card records are also produced, from which the information is periodically transferred to magnetic tape. This information may then be used as data to produce summaries of air sample results over any period for any location in a building or laboratory. The system deals with 16,000 air samples a year and the working time required to measure and keep records has been reduced from about 60 man hr/week to about 20 man hr/week for a capital cost of about £2700. (auth) (UK)

41713 IMPROVEMENTS IN AND RELATING TO A METHOD OF MEASUREMENT OF ELECTRIC CHARGES. Cluchet, Jean; Tabot, Leon (to Commissariat a l'Energie Atomique). British Patent 1,188,470. 15 Apr 1970. Priority date 17 Nov 1967, France.

A method of accurate measurement of an electric charge is described for particular application to the measurement of radiation doses absorbed by an ionization chamber. An electrometer is employed as a zero-setting device in the apparatus in which the moving system is brought to a constant reference position by application of an adjustable voltage that can be accurately measured. (B.L.M.)

41714 DATA REDUCTION COMPUTER FOR RADIATION COUNTING EQUIPMENT. (Beckman Instruments, Inc.). British Patent 1,188,990. 22 Apr 1970. Priority date 10 Oct 1966, United States.

A computer having improved data reduction facility for use with radiation detection and counting equipment is described. The computer performs addition, subtraction, and division by successive subtractions of digits and digit shifting. Division can be performed to yield desired counts-per-minute calculations without employing any auxiliary data registers. Division operation requires a minimum of control electronics, including only three simple counters and associated timing and gating circuits. Only one of the counters is required for addition and subtraction operations. (B.L.M.)

41715 TEMPERATURE MEASUREMENT OF IRRADIATION CAPSULES OR OTHER DEVICES IN A HYDRAULIC OR PNEUMATIC CONVEYOR. Mathieu, Francois; Meier, Rolf (to European Atomic Energy Community). British Patent 1,201,286. 5 Aug 1970. Priority date 11 Jul 1967, Belgium.

An apparatus for remotely measuring the temperature of a shuttle or rabbit movable within a tube containing a fluid conveyor includes a thermocouple on the shuttle and plug and socket electrical connections on the shuttle and conveyor tube that are automatically engageable as the shuttle reaches a certain position. The connections on the shuttle lead to the thermocouple and those on the conveyor lead to temperature measuring means responsive to the output of the thermocouple. The apparatus is particularly applicable to the measurement of temperature of irradiated capsules brought to the core of a nuclear reactor by a concentric tube-type hydraulic or pneumatic conveyor. (B.L.M.)

41716 NUCLEAR MAGNETIC RESONANCE MAGNETOMETER OF THE SPIN COUPLING TYPE. (to Commissariat a l'Energie Atomique). British Patent 1,193,468. 3 Jun 1970. Priority date 23 Aug 1966, France.

The NMR magnetometer described in patent No. 1,137,302 has been modified to include two samples and two coils with each pair

of replacement coils being connected together in series and having mutually perpendicular axes. (B.L.M.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 42751, 42752, and 42766.

41717 COPPER-DOPED RADIATION-RESISTANT n/p-TYPE SILICON SOLAR CELLS. Akira, Usami (Nagoya Inst. of Tech., Japan). Solid-State Electron.; 13: 1202-4(Aug 1970).

Copper was introduced into a boron-doped p-type pulled crystal (resistivity 5.0 to 10.00 Ω-cm.) by diffusion in N_2 carrier gas before junction fabrication. Gamma-ray irradiation (^{60}Co source) was performed at room temperature. The short circuit current, maximum power and the matching load resistance at maximum power were measured and changes in their values due to γ-radiation are shown graphically. Results show that the copper vacancy complex center introduced by γ-irradiation reduces recombination and that the more radiation-resistant n/p type solar cell can be made by appropriate copper doping. (UK)

41718 EFFECT OF PULSED IONIZING RADIATION ON LASER ACTION IN YAG:Cr–Nd. Derr, Vernon E.; McNice, G. T.; Kelly, E. A.; Rushworth, P. M. (Martin Marietta Corp., Orlando, Fla.). Contract AF33(615)-2022. Proc. IEEE (Inst. Elec. Electron. Eng.); 58: 846-7(May 1970).

YAG:Cr–Nd is introduced as a laser material which resists the laser cutoff effect (quenching of laser action in solids by ionizing radiation) to sufficiently high doses to allow continuation of the postponed attempts to utilize nuclear energy in the pumping of solid-state lasers. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 41295, 41313, and 41935.

Basic Processes

Refer also to abstracts 41796, 41948, 41949, and 42025.

41719 (ANL–7635, pp 67–88) THEORETICAL BIOLOGY. (Argonne National Lab., Ill.).

Multifactorial analysis was used as a tool for the study of evolutionary and organizational aspects of mammalian structure and function. Applications of factor analysis are described for studies on relation of longevity of mammalian species to brain structure; relation of life-span to hypophysis size and structure; relation of life-span to metabolic rate, brain weight, and body weight; and relation of gestation time to brain and body weight at birth, and to the factors of increase of these from birth to maturity. Progress is reported on computer simulation of percent labeled mitoses curves and its application to correlations between the sojourn times of cells in the four phases of the life cycle. Studies were conducted on the area rule of cell kinetics. As an application of the rule, experiments with beagles that were injected with tritiated thymidine are described. Curves for labeling indices of nonproliferative compartments in the granulopoietic system are presented. The four compartments are: metamyelocytes, band cells, mature neutrophils in marrow, and circulating cells. Areas under the curves were obtained and significance of the results are discussed. Research was continued on Helmstetter and Cooper's model for bacterial replication. Equations are derived for expressing relations between probability density function of interinitiation times and probability density function of delay times. Mathematical models were developed for the average cellular volume in synchronized cell populations and for the distribution of cellular volumes in exponentially growing populations. The kinetics of photoreactivation in Escherichia coli are described using a binomial-sequential model and random models. A three-dimensional model for rhythmic flowering cycles in Xanthium is presented. (H.L.W.)

41720 (ANL–7635, pp 115–53) MECHANISMS OF CARCINOGENESIS. (Argonne National Lab., Ill.).

Thymidine-2-^{14}C and ^{3}H-thymidine were used in double-label autoradiography studies on DNA synthesis in the epidermis of mice. Correlations between labeling indices and flow rates confirmed the hypothesis that, during the 24 hr period studied in the epidermis, the flux of cells from G into S was actually changing, and that this change was sufficient to cause the diurnal rhythmicity in the number of cells in DNA synthesis and in subsequent compartments of the mitotic cycle. Mice were given 2500 and 5000 R of β radiation from a ^{90}Sr–^{90}Y source. Two weeks later, croton oil was applied to the skin as a promoter. Some epilation occurred in the 2500 R group and marked epilation occurred in the 5000 R group. No increase in skin tumor incidence was seen; this result is at variance with observations of other workers where 80% of the animals developed tumors within six months after application of croton oil. Studies were conducted on the time pattern of ^{239}Pu distribution in bone, liver, and spleen of castrate and normal rats; the deposition patterns of the two groups of rats did not differ. A higher incidence of osteogenic sarcomas was observed in the castrated rats. Discs containing ^{90}Sr–^{90}Y and nonradioactive discs were implanted subcutaneously in dogs; no tumors were observed. In rats non-radioactive implants gave a sarcoma production of 15 to 30% per disc and radioactive discs caused tumor production in 95% of the animals. Effects of various types of non-radioactive implants on tumor incidence were studied. A literature survey was made of tissue: plasma levels of ^{85}Sr after single injections; results are tabulated. Experiments on ^{85}Sr retention in dog spermatozoa led to the conclusion that deposition of radiostrontium in sperm cannot be a significant factor in fallout hazard. Studies on cell proliferation and carcinogenesis included implantation of temperature-sensitive, miniature radio transmitters in the abdomen of two hamsters. Tritium-labeled thymidine was injected into other hamsters and autoradiographic observations of basal cells in the cheek pouch were made. No tumors were observed in the cheek pouch during the first six months after x irradiation. Of 44 hamsters inoculated with SV-40 virus, two developed fibrosarcomas of the cheek pouch and one lipoma was observed. Autoradiographic observations were made of rat mammary gland cells using tritium-labeled thymidine. Incorporation in DNA varied with the phase of the estrus cycle and was reflected in specific activity of DNA and labeling index. Attempts to grow HeLa cells in an Eisler-Webb Nephelostat were successful. A procedure was devised to study the two half-reactions of ornithine aminotransferase in the rat liver using ^{14}C as a tracer. Metabolic and morphologic studies of hepatocarcinogenesis in the rat were conducted using acetylaminofluorene and phenobarbital. Ornithine aminotransferase was localized in rat liver using immunofluorescence techniques. Progress is reported on optimum beam energy and geometry for neutron capture therapy and neutron depth dose computations in slab, cylindrical, and anthropomorphous phantoms. Studies on instruments and materials used for neutron depth dose distributions included analysis of irradiated Tribolium larvae and the flour media, rat and mouse tissues, and calibration of small tissue equivalent ion chamber pairs. Studies on tissue equivalent phantoms for standard man and muscle included collection of data on composition, density, and geometry for organs and tissues so that tissue equivalent systems could be devised. Dosimetry of small ^{252}Cf sources in a human phantom was studied and graphs are presented to show γ, neutron, and total dose rate as a function of distance from the source. Quantitative determinations of homogenates of rat and mouse tumors showed that the hydrogen peroxide concentration was two to three times as great as that of healthy tissue; the significance of this finding for chemotherapy is discussed. A computer program was developed for least squares adjustment of hydrolysis data for antitumor compounds of platinum(II). Cerenkov counting in combination with liquid scintillation counting was used for measuring energetic β emitters (^{32}P, ^{131}I, ^{24}Na, ^{90}Y, ^{42}K, and ^{47}Ca). (H.L.W.)

41721 (STI/DOC–10/108) RICE FERTILIZATION. A Six-Year Isotope Study on Nitrogen and Phosphorus Fertilizer Utilization. Technical Reports Series No. 108. (International Atomic Energy Agency, Vienna (Austria)). 1970. 184p. IAEA $5.00.

Experiments on rice fertilization were carried out during 1962 to 1968 in rice-growing countries by scientists of the Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture of the Agriculture Section of the IAEA Laboratory at Seibersdorf. Studies on phosphate fertilization using ^{32}P led to the following results. Surface placement was superior to shallow or deep placement. Mixing ammonium sulfate and superphosphate stimulated phosphorus uptake from fertilizer placed at a shallow depth but not on the surface. Applications of superphosphate to nurseries had no effect on the relative utilization of soil and fertilizer phosphorus after transplanting. Late timing and splitting up of phosphorus applications resulted in a slight reduction in the utilization of phosphorus from the fertilizer. However, the reduction was small and did not preclude late applications when other factors intervene such as late arrival of the fertilizer during the growing season. Flooding generally tended to increase the soil phosphorus supply but did not appreciably affect the availability of phosphorus from superphosphate. On rice soils in South-East Asia the increase in soil phosphorus availability upon flooding was often relatively small. From comparisons of natural phosphate sources when labeled superphosphate was used as a standard or with directly labeled phosphorus fertilizers, it was possible to make generalizations in relation to the availability of phosphate sources on various soil types. Studies on nitrogen fertilization using ^{15}N led to the following results. When ^{15}N-labeled $(NH_4)_2SO_4$ was used on large-scale field trials, it was found that the efficiency of nitrogen utilization for most soil types could be greatly increased by placing the fertilizer at 5 to 15 cm depth at transplanting time or by applying it two weeks before primordial initiation on the surface as one single dose. In field and pot experiments it was found that in soils of extremely low or high pH the depth of placement had no appreciable effect on the utilization of nitrogen from the fertilizer. Ammonium sulphate, Ammonphos B (mono ammonium phosphate-ammonium sulphate), and urea behaved similarly in respect to timing and placement. $NaNO_3$ was inefficient as a source of nitrogen, although late applications were slightly better than early ones. NH_4NO_3 and nitric phosphate were less available than ammonium sulphate and urea. Greenhouse experiments suggested that the greater effectiveness of shallow placement as compared with surface application of $(NH_4)_2SO_4$ on the utilization of nitrogen from the fertilizer was caused by gaseous losses of nitrogen from the surface. Depending on soil type, the losses may be as high as 70% of the applied fertilizer. Sterilization of the soil by means of radiation and subsequent growing of rice under sterile conditions showed that the effect of placement of

$(NH_4)_2SO_4$ disappeared. This illustrates the role of microorganisms in explaining the losses of nitrogen from fertilizers in acid to neutral soils. Direct losses of ammonia can take place in calcareous soils. (H.L.W.)

41722 (TID-25463) FURTHER DEVELOPMENT OF RADIOISOTOPE TECHNIQUES FOR MEASURING WATER MOVEMENT IN LARGE TREES. Owston, Peyton W.; Smith, James L.; Halverson, Howard G. (Forest Service, Berkeley, Calif. Pacific Southwest Forest and Range Experiment Station). 10 Mar 1970. Contract AT(49-11)-2773. 38p. Dep. CFSTI.

Radioisotope studies in the Sierra Nevada of California have progressed to the point where first approximations may be made of the volume of water moving through boles of individual trees. Phosphorus-32 was injected into 60-year-old lodgepole pine by immersing small lateral roots into vials of radioisotope solution. Rates of ascent of water movement in the bole were measured from autoradiographs. The rate and area measurements were then combined into estimates of water flux. These estimates for an individual tree ranged from 0.1 liter/hr for long-term movement in winter to 30.6 l/hr for short-term movement during ideal transpiration conditions. The possibilities of using this technique for operational estimates over large areas and for long time-periods are discussed. (auth)

41723 TRITIUM-HYDROGEN EXCHANGE IN INSOLUBLE COLLAGEN. Kingham, D. J.; Brisbin, D. A. (Univ. of Waterloo, Ont.). Can. J. Biochem.; 46: 1199-1203(Oct 1968).

The rate and extent of exchange of collagen fibers with tritiated water were investigated under various conditions, and four classes of hydrogen atoms were distinguishable. Of these classes, one exchanges too rapidly to be measured by this technique, a second exhibits rate curves similar to those observed in the absorption of water vapor, and a third class of hydrogen atoms shows a pH dependence remarkably similar to that expected for the titration curve of collagen. Lithium bromide treatment releases the fourth class for exchange as it severs the hydrogen bonds and destroys the structural features of the collagen macromolecule. Comparison of exchange under moderate chemical conditions with the total exchange suggests that two out of three peptide imino hydrogens may be hydrogen bonded in insoluble collagen, as is also suggested by one of the models proposed for the structure of the collagen macromolecule. (auth) (Canada)

41724 DETECTION OF ALLOGRAFT SENSITIVITY IN MICE USING ^{51}Cr-LABELED PERITONEAL MACROPHAGES. Ronai, P. M. (Univ. of Sydney). Pathology; 2: 21-32(1970).

Immunological rejection of a dispersed cell graft was assayed in mice, the test graft consisting of allogeneic mouse peritoneal cells of which only the macrophages were labeled with ^{51}Cr. A highly significant ($p < 0.001$) secondary response was demonstrated in spleen, lymph node, and bone marrow, but a significant primary response ($p < 0.01$ over 48 hr, $p < 0.001$ over 12 days) occurred only in lymph node. The secondary response was detectable 1 hr after injection, the primary response in 6 hr. This phenomena is immunologically specific, and can be passively transferred with immune serum but not with immune spleen cells. This technique can be used as a sensitive means of detecting secondary immune responses against transplantation antigens. (auth-Australia)

41725 DETERMINATION OF BROMINE IN HUMAN TISSUES BY NON-DESTRUCTIVE ACTIVATION ANALYSIS. Malvano, R. (SORIN, Saluggia, Italy); Kwiecinski, S.; Grosso, P. J. Nucl. Biol. Med.; 12: 152-6(Oct-Dec 1969).

Bromine traces in biological tissues were determined by a non-destructive procedure based on irradiations in reactor epithermal neutrons (Cd-lined samples) and ^{82}Br measurements by direct γ-spectrometry. The effectiveness and the precision of the method are discussed and the results obtained for different human tissues and organs reported and compared with the data of the literature. (auth)

41726 ASSOCIATION OF LACTOFERRIN WITH SPECIFIC GRANULES IN RABBIT HETEROPHIL LEUKOCYTES. Baggiolini, M.; de Duve, C.; Masson, P. L.; Heremans, J. F. (Rockefeller Univ., New York. Univ., Louvain, Belg.). J. Exp. Med.; 131: 559-70(1 Mar 1970).

Lactoferrin was identified in rabbit heterophil leukocytes on the basis of its immunological reactivity, electrophoretic mobility, acid-resistant iron-binding properties, and spectral characteristics. Leukocyte lactoferrin was exclusively localized in the specific (secondary) granules, which were resolved from other subcellular components by zonal differential centrifugation and by isopycnic equilibration. (auth)

41727 AUTORADIOGRAPHIC METHOD FOR ELECTRON MICROSCOPY. PHOTOGRAPHIC PROBLEMS AND THEIR SOLUTION. Rechemann, R. V.; Melloni, M.; Wittendorp, E. (EURATOM-ITAL, Wageningen, Netherlands). Acta Histochem., Suppl.; No. 8, 139-54(1968). (In French).

An autoradiographic e.m. technique with the emphasis on reproducibility and effectiveness has been developed. This was obtained by strict control. Effectiveness (i.e. the amount of information) was increased by keeping the regression of the latent image to a minimum, by development in the best possible conditions, and by using a relatively thick layer which hardly reduced the power of autoradiographic resolution. (Excerpta Med.)

41728 MEASUREMENT OF TOTAL BODY CALCIUM (BONE MASS) IN VIVO WITH THE USE OF TOTAL BODY NEUTRON ACTIVATION ANALYSIS. Nelp, Wil B.; Palmer, H. E.; Murano, Robert; Pailthorp, Keith; Hinn, Gervas M.; Rich, Clayton; Williams, James L.; Rudd, Thomas G.; Denney, John D. (Battelle-Northwest, Richland Wash. Univ. of Washington, Seattle). Contract AT(45-1)-2046. J. Lab. Clin. Med.; 76: 151-62(Jul 1970).

A system for measurement of total-body calcium in vivo was developed with the use of whole-body neutron activation analysis and whole-body counting. The precision for measuring induced ^{49}Ca is 1.2% (coefficient of variation (C. V.)), and repetitive measurements of cadavers were reproducible with a C. V. of 1.6% or better. Combined precision for a single measurement is estimated at 2.0%. In this system the patient serves as his own control, and serial changes of total-body calcium of 3% should be detectable. The irradiation with 4 to 12 MeV neutrons lasts 1 to 1.5 min, and three 12.5 min body counts are required in the following 4 hr. Details of the activation and counting technique are included. Initial total-body calcium measurements were done in patients with metabolic bone disease. (auth)

41729 HEMODYNAMIC FUNCTION STUDIES WITH RADIOACTIVE TRACERS. Mundschenk, H.; Fischer, J.; Wolf, R. (Univ., Mainz). Int. J. Appl. Radiat. Isotop.; 21: 199-211(Apr 1970). (In German).

A new set-up, a multichannel function test device, is described for performing hemodynamic function studies with radioactive tracers. After injection of radioactive labelled particles of definite physical and chemical properties, the distribution of radioactivity can be registered simultaneously as function of time at six different sites of the body. Each of the six detectors used, one of them can be replaced by a fore-arm counter, is equipped with two channels, which can be individually adjusted to the photopeaks of two different radioisotopes. The data are either/not only stored on magnetic tape or/but also fed into a memory unit operating in multiscaler mode. The memory of the multiscaler is divided into 16 sub groups of 256 storage places each; each subgroup is assigned to one channel of a detector. The pulses, stored on the magnetic tape, can be fed into the memory at different counting times enabling an optimum interpretation of the measured activity curves. The direct storing mode under standard conditions is advantageous because of its considerable time saving in routine work. The memory content of the multiscaler can be read out logarithmically by an XY-recorder. By this, decomposition of the ordinarily complex elimination curves is made easily and determination of the elimination constants can be done directly. The activity curves of accumulation processes which can be represented normally by complementary exponential functions, are differentiated electronically, read out logarithmically and evaluated in the usual manner. Furthermore, the set-up described allows the continuous registration of fast proceeding processes with rate constants in the msec-range. (auth) (UK)

41730 CAPILLARY PERMEABILITY IN HUMAN SKELETAL MUSCLE MEASURED BY LOCAL INJECTION OF ^{51}Cr-EDTA AND ^{133}Xe. Trap-Jensen, J.; Korsgaard, O.; Lassen, N. A. (Bispebjerg Hospital, Copenhagen. Rigshospitalet, Copenhagen). Scand. J. Clin. Lab. Invest.; 25: 93-9(1970).

The skeletal muscle capillary permeability for ^{51}Cr-EDTA, expressed as the Capillary Diffusion Capacity, $CDC_{Cr\text{-}EDTA}$, was measured in normal man after simultaneous injection of ^{51}Cr-EDTA and ^{133}Xe into the anterior tibial muscle. During local hyperemia $CDC_{Cr\text{-}EDTA}$ averaged 3.5, SD 0.7 moles/100g/min per mole/ml. Inhalation of carbon monoxide or local injection of histamine combined with local hyperemia did not influence the permeability significantly. In contrast local injection of hyaluronidase and hyperemia caused a highly significant increase in the permeability of the capillary wall. (auth) (Denmark)

41731 A SENSITIVE DOUBLE-ISOTOPE DERIVATIVE ASSAY FOR NOREPINEPHRINE AND EPINEPHRINE. NORMAL RESTING HUMAN PLASMA LEVELS. Engelman, Karl; Portnoy, Barry (National Heart Inst., Bethesda, Md.). Circulation Res.; 26: 53-7(Jan 1970).

A sensitive and specific double-isotope dilution method for

assaying norepinephrine and epinephrine separately is described. The method is based on enzymatic conversion of these two catecholamines to their respective metanephrines and was applied successfully to measurement of resting plasma concentrations of norepinephrine and epinephrine in normal subjects with the finding that norepinephrine (0.20 ± 0.08 μg/liter) normally constitutes approximately 80% of the plasma catecholamine content and epinephrine (0.05 ± 0.03 μg/liter) 20%. (auth)

41732 USE OF ^{75}Se-METHIONINE FOR THE IN VIVO STUDY OF PLATELET KINETICS. Najean, Y.; Ardaillou, N. (Hopital Saint-Louis, Paris). Scand. J. Haematol.; 6: 395-401(1969).

Platelet kinetics were studied using ^{75}Se-methionine as an in vivo tracer in normal and aplasic rats in normal man and in patients suffering from bone marrow inadequacy, thrombocytosis, thrombocytopenia due to hyperdestruction. Results are compared with those obtained with ^{51}Cr-labelling. The method is found useful to measure both platelet production and autologous platelet life span in thrombocytopenic patients. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 41680, 41789–41791, 41795, 41863, 41865, 41866, 41872, 41892, 41931, 41957, 41976, and 41990.

41733 (ANL–7635, pp 93-114) TOXICITY AND METABOLISM OF RADIONUCLIDES. (Argonne National Lab., Ill.).

Problems concerning dosimetry of radioisotopes following exposure to reactor accidents and nuclear detonation are discussed. Beagle dogs were exposed for the duration of life to ^{60}Co γ radiation at rates of 5 to 35 R/day. Results led to the conclusion that there were inherent differences in marrow cell regenerative and repair capabilities among individual dogs exposed continuously to irradiation. A marked dose-response reduction in cell populations of venous blood occurred during the first 200 days following daily exposure of dogs to radiation. The dose-response effect disappeared during the second period; the dogs produced nearly equivalent numbers of leukocytes, erythrocytes, and thrombocytes. Cultures of blood and tissues from dogs exposed to continuous γ radiation were prepared and a table is presented to show bacterial findings. The usual causes of bacteremia were Pasteurella multocida and β-hemolytic streptococci. Studies on pathology showed that septicemia and anemia were the main causes of death following protracted irradiation. Lesions occurring in two cases of myeloproliferative disease are described. Cesium-137 retention at various times after injection was determined for dogs ranging from 61 to 588 days of age at injection. It was found that the specific rate of change of retention is a continuously decreasing function of age and is not influenced by the particular age at injection. The cycle of accommodation to restricted dietary iodine in the beagle thyroid was studied. After 368 days the size and weight of the thyroids were about three times the normal. No changes in the pituitary or adrenal glands were noted. Major changes in thyroid iodine metabolism as measured by test doses of ^{131}I were noted. The pathology and familial incidence of thyroiditis in a closed beagle colony were examined. Although the histologic features and total incidence of thyroiditis in adult dogs given lethal or near-lethal doses of ionizing radiation was distinctly different from thyroiditis in unirradiated dogs, its incidence was genetically influenced in the same manner as in unirradiated adults. The biologic half-time of ^{131}I in the thyroid was found to be a practical method for establishing the presence of thyroid lesions in a beagle colony with a high incidence of thyroiditis. Skin graft survival in partially inbred beagles was studied. A comprehensive program is described for definition of inbreeding, relationships, and ancestral composition within a closed beagle colony. The ultrastructure of normal hemopoietic cells from dog bone marrow was studied and photographs are presented of osteoblasts, megakaryocytes, myelocytes and other bone marrow cells. (H.L.W.)

41734 (ANL–7635, pp 292-302) CELLULAR FINE STRUCTURE. (Argonne National Lab., Ill.).

Tritium-labeled palmitic acid was administered to rats for studies on lipids in the liver cell nucleus. It was found that at least 85% of the total radioactivity in the isolated nuclei was still present in the palmitic and oleic acids isolated by thin layer chromatography following exhaustive acid hydrolysis. Autoradiography was used for distinguishing between lipids associated with the membranes of the nuclear envelope and lipids associated with the chromatin and the nucleoli. Cellular fine structure studies also included effects of actinomycin D on grasshopper spermatogenesis. (H.L.W.)

41735 (BRH/DBE–70-1, pp 39-58) TOXICOLOGIC STUDIES SECTION. (Public Health Service, Rockville, Md.).

Studies were conducted on the effects of ^{89}Sr on the hematopoietic system of cats; increased body burden in kittens after in utero exposure to ^{85}Sr; ^{85}Sr body burdens in cats by drenching; safety procedures in a long-term radiostrontium experiment utilizing an outdoor feline colony; use of isodensitometry for ^{90}Sr dose-rate responses in young and adult cats; and pathologic effects of continuous ^{89}Sr ingestion in mice. (H.L.W.)

41736 CALCIUM AND STRONTIUM METABOLISM IN LACTATION. Durakovic, A. (Inst. for Medical Research, Zagreb). Arh. Hig. Rada Toksikol.; 19: 79-87(1968). (In Croatian).

Changes in the comparative metabolism of Ca and Sr in the course of lactation are reviewed (28 references) with particular attention to ^{90}Sr deposition and mobilization in the skeleton. Special emphasis is also placed on skeletal accumulation of Ca and Sr during pregnancy, on the localization of alkaline earth ions in different fractions of the skeleton, as well as on the influence of lactation on these incorporated cations. A survey of Ca and Sr metabolism in the exchangeable and nonexchangeable fractions of bone is presented, as dependent upon the duration of lactation and the transfer of these cations from the mother rat into the fetus and milk. Particular attention is paid to the possibility of radiostrontium mobilization from bone during lactation as well as to the influence of lactation on the development of malignant tumors due to radiostrontium incorporation. The review also deals with relations between the radiostrontium incorporated in the mother's skeleton and its transfer into the young rat during lactation. (BBB)

41737 EXPERIMENTAL STUDIES ON THE INCORPORATION OF ^{32}P AND ^{35}S IN THE GENITAL ORGANS OF THE RAT AND ITS DEPENDENCE ON SERUM GONADOTROPIN. Hofmann, D.; Menkhaus, G. (Westfaelische Wilhelms Univ., Muenster, Ger.). Zentralbl. Gynaekol.; 91: 565-78(3 May 1969). (In German).

Incorporation of ^{32}P and ^{35}S into ovary, uterus, liver, and blood was studied in rats by tissue analysis and by autoradiography. Administration of serum gonadotropin caused a striking enhancement of incorporation. Exsanguination demonstrated that the major part of radioactivity following serum gonadotropin administration was caused by hyperemia. Following ovarectomy, ^{35}S activity in the uterus was not increased by gonadotropin. Autoradiography revealed that ^{32}P predominantly concentrated in the granulosa cells of the follicles but did not enter the follicular fluid. Sulfur-35, in contrast, entered the granulosa cells only initially and then concentrated in the follicular fluid. (tr-auth)

41738 FIXATION AND PHYSIOLOGICAL ACTION OF ^{60}Co IN SOME CULTIVATED PLANT SPECIES. Kirchmann, R.; Colard, J.; Fagniard, E. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). pp 667-88 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

A report is given of hothouse experiments aimed at determining the cobalt toxicity threshold and the symptoms of intoxication and the order of their appearance in Pisum sativum grown in solutions and on different types of soil containing variable amounts of cobalt are described. The influence on the root system (inhibition of the growth of the main root and nonformation of secondary roots) and on the development of the aerial part is demonstrated. Hydroponic experiments on the fixation and transport of ^{60}Co in Pisum sativus at various stages of development are also described and the results discussed. Observations on the behavior of young purple clover, carrot and beetroot plants cultivated on soil containing up to 240ppm of Co^{++} are reported. The fixation of radio-cobalt and its distribution in various organs of plant species (ryegrass, clover, turnip, barley) were studied under conditions simulating a temporary flood on the one hand, and from uniformly contaminated soil and drainage mud on the other. (auth) (France)

41739 ASPECTS OF STRONTIUM AVAILABILITY AND ABSORPTION BY PLANTS IN CHALKY SOILS. Guennelon, R.; Conesa, A. P.; De Cockborne, A. M.; Drujon, P. (Institut National de Recherches Agronomiques, Montfavet, France). pp 761-80 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

The interaction of strontium with calcium carbonate was studied. A maize crop produced on a simplified model shows that the presence of polyphosphate causes an appreciable increase in the absorption of strontium by the young shoots as compared with the orthophosphate treatment, the presence of chelates leading to a reduction under experimental conditions. A rye grass cultivated on a ^{90}Sr-contaminated chalky soil, in which was incorporated a

chelate or a polyphosphate or organic matter, showed no increase in its ^{90}Sr content with respect to the contaminated reference crop treated simply with orthophosphate. (auth) (France)

41740 SOIL SOLUTION AND ITS INFLUENCE ON THE UPTAKE OF ^{90}Sr AND CALCIUM BY ALFALFA. Csupka, S. (Regional Station of Hygiene, Bratislava). pp 883-93 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

A study was made of 2 types of soil with different exchangeable Ca content. The Ca and ^{90}Sr concentrations in the extracts obtained by extraction with deionized water, 1 N ammonium acetate and 6 N hydrochloric acid were determined. This gradual extraction gives an idea of the mobility and migration of ions in soil solutions and shows that the selection of ^{90}Sr from the soil is dependent on the Ca exchangeable content of the soil. The ^{90}Sr and Ca absorption by alfalfa was measured and the discrimination factors were calculated. The influence of rainfalls and radioactive fallouts on the ^{90}Sr content of the soil and alfalfa is discussed. (auth) (France)

41741 ABSORPTION OF COBALT BY IRRIGATED RICE: INFLUENCE OF THE CONCENTRATION IN THE NUTRITIVE ENVIRONMENT AND OF THE CHEMICAL FORM OF THE COBALT. Myttenaere, C. (EURATOM, Ispra, Italy). pp 895-906 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

Indirect contamination (soil and irrigation water) is responsible for an appreciable fraction of the radioactivity of rice plants harvested in irrigated rice fields. The irrigation water has proved to be a much more important contamination factor than the soil, and the transfer factors obtained between water and plants are identical with those observed in crops grown in solutions. ^{60}Co is one of the main radioisotopes discharged into Lake Major by the Ispra Center, the water of this lake being used for the irrigation of various crops (by spraying and flooding) including irrigated rice. A first experiment was carried out by aquiculture on gravel to study the influence of the dose and chelation of the Co in the nutritive environment on the ^{58}Co content of various organs of the plant. No significant reduction in yield and no symptom of toxicity were observed for the concentration range considered (0 to 5 ppm). The specific activity of the whole plant expresses an absorption proportional to the amount of Co present in the nutritive medium. However, the smaller this quantity the more the Co is fixed in the region of the roots, while the opposite phenomenon is observed for the aerial part of the plant. The transfer factor varies according to the organ in question and is close to unity for the endosperm. The chelation of cobalt appreciably reduces the activity levels of the various organs analyzed. Under the experimental conditions, the Fe and Mn contents of the plants are not a function of the stable Co concentration of the medium and consequently of the plant. The use of chelated Fe no doubt greatly reduced the influence of Co. From a health point of view the consumption of rice as a staple food seems to pose no serious problem. (auth) (France)

41742 COMPARISON OF THE RADIUM AND URANIUM CONTENTS OF PLANTS HARVESTED ON URANIFEROUS LAND. Delpoux, Marcel (Univ., Toulouse). pp 909-21 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

Earlier work established the radium contents of 20 species belonging to the spontaneous flora of uraniferous lands of the Monts d'Ambazac, Haute-Vienne (France). Later on, the same samples of plant ash were used to determine the uranium content. In both cases, where the ground is highly radioactive, the variation in the concentration of these radioelements is independent of that of their concentrations in the soils. There even seems to be a decrease in the uranium and radium absorption in the most radioactive stations. In addition, the ashes of the most radium-rich plants (for example Vaccinium myrtillus: 3757×10^{-12} Ci per gram of ash) contain only 13 parts per million (ppm) of uranium whereas Deschampsia flexuosa (L.) TRIN., that is the richest in uranium amongst the species studied (185 ppm), only contains 440×10^{-12} Ci of radium per gram of ash. For each species therefore the radium and uranium absorption exhibit a large degree of independence. The main phenomena brought to light are a double absorption selectivity (variation between species towards the same radioelement and different behavior of each species towards uranium and radium). This gives a possible explanation of the wide differences observed between individual plants and gives quantitative support to knowledge of the radioactivity peculiar to plants developing on uraniferous land. (auth) (France)

41743 UPTAKE OF FALLOUT RADIOACTIVITY BY PLANTS ON THE TERRITORY OF THE BORIS KIDRIC INSTITUTE OF NUCLEAR SCIENCES. Tasovac, T.; Radosavljevic, R. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). pp 983-97 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

In order to estimate the ecologic specific conditions of the environment and to evaluate the accumulation of radioactive nuclides in various components of ecosystems, systematic measurements of the radioactivity of plants were carried out for a long time at the Boris Kidrič Institute of Nuclear Sciences. Correlations of the changes in radioactivity with specific environmental parameters are made. (auth) (France)

41744 ^{90}Sr CONTAMINATION OF THE SKELETON AND MILK TEETH IN SWITZERLAND. Lerch, P.; Geering, J.-J.; Lorenz, Ch. (Ecole Polytechnique Federale, Lausanne, Switzerland). pp 1025-38 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

The ^{90}Sr content of the skeleton of Swiss adults was determined over the last 10 years (50 to 100 analyses each year). This contamination first increases exponentially, reaching a maximum in 1967 and starting to fall in the following years. The maximum lies at 2.8 pCi ^{90}Sr/g Ca, well below the maximum dose permissible for the population as a whole. No significant regional differences are observed. Six collections of milk teeth from the principal towns in Switzerland were used to determine the pattern of contamination in young children. Until 1968 and in general, for each run, the youngest children were also the most contaminated; from one run to the next the ^{90}Sr content was found to increase for each group of children. The results of the last run (1968) showed a contamination maximum, the highest values observed belonging to children born in 1961 and aged 6: the ^{90}Sr concentration reached 4.4 pCi/g Ca. (auth) (France)

41745 RADIOCESIUM DISTRIBUTION AND RADIATION DOSES DETERMINED IN THE VARIOUS ORGANS OF THE HUMAN ADULT AND FETUS. Nay, U. (Tuebingen Univ., Ger.). pp 1057-63 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

The distribution of ^{137}Cs was measured in the bones and soft tissues of the human adult, youth and fetus. The highest specific activity is found in the muscles, the ratio of the activity in the skeletal muscles to that in the compact bones being 16 to 1. The organs are less radioactive than the muscles, and of those studied (liver, spleen, lungs, brain) the liver has the highest ^{137}Cs content. This applies particularly to the liver of the fetus. The distribution is not dependent on age. The β and γ doses for the various organs were established. In newborn infants the β/γ dose ratio is 40% higher for muscle than for bone marrow, whereas in the adult weighing 70 kg the ratio is 17 to 1. In 200 births a placental discrimination of 4.1 was established in the blood of the umbilical vein and in the veinous blood of the mother. If this discrimination is established between the ^{137}Cs contained in the muscles of the mother and the fetus a slightly lower figure is obtained. (auth) (France)

41746 EMBRYONIC UPTAKE OF ^{45}Ca AND ^{89}Sr. Mraz, Frank R. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-GEN-242. Poultry Sci.; 49: 310-11(Jan 1970).

The uptake of ^{45}Ca and ^{89}Sr by chick embryos following injection into the egg at 4- and 8-day incubation was studied. After the 14th day of incubation, a progressive increase in the uptake of both radioisotopes was observed in the tibia and the whole embryo. There was no apparent differentiation between ^{45}Ca and ^{89}Sr as far as uptake or bone deposition was concerned. (E.R.B.)

41747 EFFECTS OF SUPPLEMENTAL POTASSIUM BICARBONATE UPON ^{24}Na AND ^{42}K METABOLISM IN YOUNG NONLACTATING COWS. Perry, S. C.; Schaffer, J. H.; Cragle, R. G.; Miller, J. K. (Univ. of Tennessee, Oak Ridge). J. Dairy Sci.; 53: 1094-6(Aug 1970).

Two sets of nonlactating fraternal twins were fed a basal ration or a basal ration plus $KHCO_3$. Each of these animals was given ^{24}Na or ^{42}K orally and intravenously so that all combinations of rations, isotopes, and methods of administration were experienced

within each twin set. Increasing dietary potassium with $KHCO_3$ by 39 to 48% (total intakes of 160 to 185 g K per day) caused no serious metabolic disturbance but increased the urinary excretion of intravenously and orally given ^{42}K and the blood level of ^{24}Na. In general, dietary $KHCO_3$ decreased the blood level of both orally and intravenously given ^{42}K, probably by simple dilution. Regardless of whether the radioisotopes were given orally or intravenously, the proportions of each isotope excreted in feces remained nearly constant and small, indicating that fecal sodium and potassium are almost entirely endogenous in origin. (auth)

41748 MESOCESTOIDES CORTI: ENVIRONMENTAL CATION CONCENTRATION IN CALCAREOUS CORPUSCLES. Kegley, Larry M.; Baldwin, Jannet; Brown, Bruce W.; Berntzen, Allen K. (Portland State Univ., Oreg.). Exp. Parasitol.; 27: 88-94(1970).

The addition of As, Be, Cd, Pb, Sr, and U to the in vitro culture environment has resulted in specific cation concentration within the inorganic constituents of the calcareous corpuscles from Mesocestoides corti. The efficiency of cation concentration is shown by compound and elemental identification using powder x-ray diffraction, emission spectrographic, and radioactivity detection methods. Divalent ions, whether added to the media or present as trace impurities in the reagents, were found to be strongly concentrated by the tetrathyridia of M. corti if the cationic radius is near that of calcium or magnesium. Ion selectivity is suggested by the small concentration of trivalent arsenic, hexavalent uranium (as UO_2^{2+}), and the inefficient concentration of the small divalent beryllium ions. (auth)

41749 CLEARANCE OF ^{59}Fe-LABELLED ERYTHROCYTES FROM NORMAL AND INFLAMED RABBIT KNEE JOINTS. II. AUTORADIOGRAPHIC AND HISTOLOGICAL STUDIES. Muirden, K. D.; Peace, G.; Rogers, K. (Univ. of Melbourne). Ann. Rheum. Dis.; 28: 630-6(1969).

Autoradiographic and histological studies of the synovial membrane have been made after the injection of ^{59}Fe-labeled erythrocytes into normal rabbit joints and into joints inflamed by previous treatment with carrageenin. Differences were found in the distribution and disappearance rate of iron. In the control joints peak levels of radioactivity were found at Day 3 and Day 7 after the injection, at a time when red cells were disappearing and haemosiderin was appearing in synovial macrophages. In the carrageenin-injected joints high grain counts were maintained until Day 14, and even at Day 42 sizeable deposits of iron were still visible. The presence of large extracellular deposits of haemosiderin in the carrageenin joints similar to those noted in rheumatoid arthritis is one reason suggested for the slower clearance from the inflamed joint. (auth)

41750 EFFECTS OF TEMPERATURE, RAINFALL, AND FAUNA ON TRANSFER OF ^{137}Cs, K, Mg, AND MASS IN CONSUMER-DECOMPOSER MICROCOSMS. Witkamp, Martin; Frank, Marilyn L. (Oak Ridge National Lab., Tenn.). Ecology; 51: 465-74(Late Spring 1970).

Microcosms containing leaf litter, sand, and three, six, or nine millipedes were incubated for 14 weeks at either 5°, 15°, or 25°C under three rates of simulated rainfall. Effects of temperature, rate of leaching, and millipede density on transfer of ^{137}Cs, K, Mg, and mass and on evolution of CO_2 were analyzed statistically and by analog computer simulation. Loss rates from litter increased in order: Mg < mass < ^{137}Cs < K; the effects of the three environmental variables on transfer also increased in the same order. Transfer of Mg was primarily to humus; mass to CO_2; ^{137}Cs to sand; and K to leachate. Loss rates of Mg and mass, evolution of CO_2, and transfers of ^{137}Cs were all influenced primarily by temperature and secondarily by millipede density. Only K was affected more by leaching than by millipedes. Production of CO_2 showed a $Q_{10} \simeq 2$, but mineral transfer did not double at each 10°C increase because of significant temperature-moisture interaction. Computer simulation showed that pathways and rate coefficients for transfer of ^{137}Cs were identical whether it originated from litter or soil, that the major pathways were from litter to soil and from litter via millipedes to soil, and that about 7% of the initial leaf ^{137}Cs was easily leached from litter and transferred to soil and leachate during the first month. At higher temperatures, drying and rewetting cycles of the litter appeared to shift the litter-to-soil transfer of ^{137}Cs from the millipede ingestion-excretion pathway to that effected by microbial immobilization-mineralization cycles. (auth)

41751 STUDY OF DISTRIBUTION OF RADIOACTIVE SUBSTANCES IN THE HUMAN BODY BY MEANS OF A BACKGROUND-FREE CHAMBER. Sereda, M. G.; Gabuniya, R. I.; Gorobets, V. F.; Kaplan, M. A.; Matveenko, E. G. Med. Radiol.; 13: No. 12, 35-40(Dec 1968). (In Russian).

A study of the distribution of radioactive substances in the body of man is presented. Using a collimated counter with an amplitude analyzer, the content of several isotopes in different organs and tissues was determined. The method permits the localization of an isotope at depth in the organ that concentrates the isotope, and provides information concerning its dimensions and the thickness of the surrounding tissues, using only an insignificant quantity of radioactive preparation (approx. 5 MμCi). Using a collimated counter along with the measurement of general radioactivity, it was possible to separate the activity heavily deposited in an organ from the activity in the surrounding tissues and to trace its change during an extended period of time. (tr-auth)

41752 ^{90}Sr IN THE HAIR AS AN INDEX OF ITS CONTENT IN THE BONE TISSUE OF MAN. Antonova, V. A.; Shvydko, N. S. (Leningrad Research Inst. of Radiation Protection). Gig. Sanit.; No. 3, 43-5(Mar 1970). (In Russian).

A definite correlation between the concentration of ^{90}Sr in the hair and its content in the skeleton is discussed. A regression equation was obtained that made it possible to determine with sufficient accuracy the specific activity of the isotope in the bone tissue judging by specific activity of ^{90}Sr in the hair. (auth)

41753 MONOVALENT-ION CARRIER EFFECTS ON TRANSPORT OF ^{86}Rb AND ^{137}Cs INTO BUSH BEAN PLANTS. Wallace, Arthur (Univ. of California, Los Angeles). Contract AT(04-1)-Gen-12. Plant Soil; 32: 526-30(1970).

Bush bean plants were exposed to either ^{86}Rb or ^{137}Cs for 24 hr with different monovalent cations as carriers in single-salt solutions except for the presence of 10^{-4} M $CaCl_2$. Ratio of uptake of the radionuclides at 10^{-3} to 10^{-2} M was used as an index of the carrier ability of various cations. Different monovalent cations decreased uptake of ^{137}Cs and its transport to shoots unequally when 10^{-2} M salts were compared with 10^{-3} M salts. Rubidium and cesium salts decreased ^{137}Cs uptake equally but potassium salts were less effective in decreasing uptake when the ratios of the two concentrations were considered. All monovalent cations decreased uptake of ^{137}Cs at the 10^{-2} M carrier concentration but some did not at 10^{-3} M. Nitrate nitrogen was a big factor in these results. Cesium and rubidium salts were most effective. Potassium appeared to increase ^{137}Cs transport to shoots particularly at 10^{-3} M KNO_3. Only cesium, rubidium, and potassium salts decreased uptake of ^{86}Rb when 10^{-2} M salts were compared with 10^{-3} M. Rubidium and cesium salts decreased uptake essentially equally and potassium salts again were less effective. All nitrate salts tended to increase ^{86}Rb transport to shoots more consistently than with ^{137}Cs. It is concluded that absorption and transport to shoots were not equivalent for potassium, rubidium, and cesium. (auth)

Radiation Effects

Refer also to abstracts 41316, 41347, 41960, and 41987.

41754 (AECL-3430, pp 5-18) BIOLOGY RESEARCH. Newcombe, Howard B. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.).

Research in the Biology Branch includes investigations in the areas of Biochemistry and Molecular Biology and Genetics, Development, and Population studies. Abstracts are presented for 22 research projects being conducted in the branch. A list of the branch staff members and of the papers published during the reporting period is also included. (E.R.B.)

41755 (COO-78-220) ANNUAL REPORT FOR PERIOD ENDING APRIL 30, 1970. Friedell, Hymer L. (Case-Western Reserve Univ., Cleveland, Ohio. School of Medicine). 8 May 1970. Contract W-31-109-eng-78. 88p. Dep. CFSTI.

Research activities are presented for the Division of Radiation Biology of the Case Western Reserve University for the fiscal year ending April 30, 1970. Reports of 23 research projects are included in the following sections: radiation physics (7); radiation cytology (5); radiation biochemistry (5); modification of radiation effects (2); and application of radioelements (4). Lists of the division staff and papers published, meetings attended, and papers presented at these meetings by the staff during the reporting period are also included. (E.R.B.)

41756 THYMINE RADIOLYSIS IN AERATED AQUEOUS SOLUTION. PRODUCTION OF THE N-PYRUVYL N'-FORMYL UREA. Teoule, Robert; Cadet, Jean; Ulrich, Jacques (CEA, Grenoble, France). Compt. Rend., Ser. C; 270: 362-4(19 Jan 1970). (In French).

A substance found to be the N-pyruvyl, N'-formyl urea through chemical and spectroscopic studies was isolated from the thymine radiolysis products. The N-pyruvyl N'-formyl urea which becomes unstable in aqueous medium gives rise to the 5-hydroxy, 5-methyl

hydantoin. Its synthesis carried out by the reaction of the sodium periodate onto the cis 5,6-dihydroxy, 5,6-dihydro thymine verified this structure. (auth-France)

41757 ULTRA-VIOLET-LIGHT-ENHANCED PRECURSOR INCORPORATION AND THE REPAIR OF DNA DAMAGE. Smets, L. A. (EURATOM, Ispra, Italy). Int. J. Radiat. Biol.; 16: 407-18(1969).

The uv-induced incorporation of labelled precursor in DNA of human kidney cells was studied. Radiation-enhanced incorporation differed from DNA replication by its specificity for pyrimidine precursors and by a lower sensitivity to actinomycin. It was concluded that no DNA templates were copied during this process. Irradiation caused single-strand breaks that were studied by means of alkaline-sucrose gradients. Many more breaks were induced in cells grown in BUdR-containing medium. Cells were capable of repairing most of these breaks. It was postulated that repair incorporation of DNA precursors and the rejoining of single-strand breaks form part of a mechanism by which mammalian cells repair damage in their DNA. (auth)

41758 REPAIR OF RADIATION-INDUCED DAMAGE IN ESCHERICHIA COLI. II. EFFECT OF REC AND UVR MUTATIONS ON RADIOSENSITIVITY, AND REPAIR OF X-RAY-INDUCED SINGLE-STRAND BREAKS IN DEOXYRIBONUCLEIC ACID. Kapp, Daniel S.; Smith, Kendric C. (Stanford Univ., Calif.). J. Bacteriol.; 103: 49-54(Jul 1970).

Strains of Escherichia coli K-12 mutant in the genes controlling excision repair (uvr) and genetic recombination (rec) were studied with reference to their radiosensitivity and their ability to repair x-radioinduced single-strand breaks in deoxyribonucleic acid (DNA). Mutations in the rec genes appreciably increase the radiosensitivity of E. coli K-12, whereas uvr mutations produce little if any increase in radiosensitivity. For a given dose of x rays, the yield of single-strand breaks was shown by alkaline sucrose-gradient studies to be largely independent of the presence of rec or uvr mutations. The rec^+ cells (including those carrying the uvrB5 mutation) could efficiently rejoin x radioinduced single-strand breaks in DNA, whereas recA56 mutants could not repair these breaks to any great extent. The recB21 and recC22 mutants showed some indication of repair capacity. From these studies, it is concluded that a correlation exists between the inability to repair single-strand breaks and the radiosensitivity of the rec mutants of E. coli K-12. This suggests that unrepaired single-strand breaks may be lethal lesions in E. coli. (auth)

41759 DEOXYRIBONUCLEIC ACID SYNTHESIS AND CELL DIVISION IN A LON^- MUTANT OF ESCHERICHIA COLI. Leighton, P. M.; Donachie, W. D. (Univ. of Edinburgh). J. Bacteriol.; 102: 810-14(Jun 1970).

The lon^- mutants of Escherichia coli form long filamentous cells after temporary inhibition of deoxyribonucleic acid (DNA) synthesis by ultraviolet irradiation, treatment with nalidixic acid, or thymine starvation. The kinetics of DNA synthesis and cell division after a period of thymine starvation have been compared in lon^+ and lon^- cells. After this treatment, both kinds of cells recover their normal DNA to mass ratio with the same kinetics. In contrast to previous reports, cell division is found to recommence in both lon^+ and in lon^- cells after such a temporary period of inhibition of DNA synthesis. However, the delay separating the recommencement of DNA synthesis and of cell division is approximately three times as long in lon^- as in lon^+ cells. Low concentrations of penicillin inhibit cell division in both lon^+ and lon^- cells. In this case, cell division recommences with the same kinetics in both strains after the removal of penicillin. This suggests that different steps in the cell division process are blocked by inhibition of DNA synthesis and by penicillin treatment. The lon^- mutation appears to affect the former of these steps. (auth)

41760 THE EFFECTS OF CAFFEINE, ULTRAVIOLET, AND X-IRRADIATION ON DNA BREAKDOWN IN E. COLI B AND SOME OF ITS DARK REPAIR MUTANTS. Grigg, G. W. (CSIRO, Epping, New South Wales). Mol. Gen. Genet.; 106: 228-38(1970).

Caffeine (4 and 8 mM) increased the rate of spontaneous DNA breakdown that occurred during normal growth of a culture of Escherichia coli Bs-11, but neither affected breakdown in the EXR strain Bs-2 nor the parental strain B. It slightly impaired the rate of DNA breakdown that follows uv-irradiation of E. coli B, but did not depress the final fraction degraded. On the other hand even 12 mM caffeine had no detectable effect on the (excessive) rate of DNA breakdown of uv-irradiated cultures of the EXR strain Bs-2. The effects of x irradiation on DNA breakdown in E. coli B and a number of its uv-sensitive and resistant mutants are described. Caffeine had no detectable effect on the kinetics of x ray-induced DNA breakdown of E. coli B. (auth)

41761 RADIOCHROMATOGRAPHIC ANALYSIS OF IRRADIATION CLEAVAGE PRODUCTS OF THYMINE ^{14}C. Nagy, Eva J.; Elekes, Istvan. Acta Pharm. Hung.; 39: 259-64(Nov 1969). (In Hungarian).

The uv-radioinduced photochemical reactions of thymine-^{14}C were investigated. It was shown by paper and thin-layer chromatography that about 10 to 20% of the original thymine-^{14}C was transformed into other photoproducts. The photochemical reaction was proportional to the dose. (auth)

41762 CHEMICAL MODIFICATIONS OF DNA BY IONIZING RADIATIONS. RADIOLYSIS OF THYMINE. Teoule, R.; Cadet, J. (CEA, Grenoble, France). Bull. Inform. Sci. Tech. (Paris); No. 145, 35-41(Feb 1970). (In French).

The chemical modifications of DNA by ionizing radiations play a prominent part in radiobiology. A basic component of DNA, the thymine, was irradiated and the radiolysis products were studied. The radioproducts were isolated by chromatography; their structures were determined by spectroscopy (I.R., U.V., N.M.R., mass spectrometry) and by organic synthesis. A balance and a new degradation pattern in aerated aqueous solution were obtained. (France)

41763 EFFECT OF ULTRAVIOLET LIGHT ON DIVISION AND DEOXYRIBONUCLEIC ACID SYNTHESIS IN HAEMOPHILUS INFLUENZAE. Kantor, George J.; Barnhart, B. J. (Los Alamos Scientific Lab., N. Mex.). J. Bacteriol.; 103: 1-8(Jul 1970).

The effects of ultraviolet (uv) light on cell morphology, deoxyribonucleic acid (DNA) synthesis, and protein synthesis in uv-sensitive and uv-resistant strains of Haemophilus influenzae were examined. Relatively low doses of uv induce lyses in the sensitive strains but not in the resistant mutant; however, uv temporarily blocks cell division of the resistant mutant, and elongated cells are formed after a period of incubation. Low doses of uv do not stop DNA synthesis in any of the strains examined; however, they do slow the rate of DNA synthesis in a manner consistent with the model correlating the kinetics of postirradiation DNA synthesis with the cell's ability to repair uv-induced DNA lesions. The data are not consistent with a model in which uv causes all DNA synthesis to stop for a time linearly dependent on dose. (auth)

41764 STUDIES ON RNA SYNTHESIS PRIMED BY DAMAGED TEMPLATES. II. HOMOPOLYRIBONUCLEOTIDE TEMPLATES DAMAGED BY γ RADIATION. Goddard, J. P.; Weiss, J. J.; Wheeler, C. M. (Univ. of Newcastle-upon-Tyne, Eng.). Biochim. Biophys. Acta; 199: 139-46(Jan 1970).

The effects of γ-irradiation of poly A and poly U upon their priming ability for complementary homopolymer synthesis and their affinity for RNA polymerase were investigated. Gamma-irradiation of poly A leads to a reduction in priming ability and increase in template affinity, ascribed to radiation-induced production of inactive binding sites (G = 0.7 site/100 eV). Gamma-irradiation of poly U led to only a small decrease in priming ability due to reiterative synthesis of poly A. The base composition of the product formed in the reaction primed by γ-irradiated poly A, poly U and poly C (under predetermined optimal conditions) was investigated by nearest-neighbor analysis. With irradiated poly U template, only poly A was synthesized but γ-irradiation of poly A template led to incorporation of GMP into the product. With irradiated poly C as template, the synthesized product contained AMP. The findings, confirmed by independent experiments, are in agreement with the earlier observation that irradiated DNA tends to be purine directing. (auth)

41765 DC CONDUCTIVITY MEASUREMENTS ON DEOXYRIBONUCLEIC ACID FILMS. Gaehwiler, B.; Zschokke-Graenacher, I.; Baldinger, E.; Luethy, H. (Univ., Basel). Biophysik; 6: 331-44(1970). (In German).

The dc conductivity in unsupported films of DNA as well as in sandwich and gap cells was investigated. A method for the preparation of unsupported films was developed. Evaporated Cr, Ag, Au, and Al as well as Au and Ag paste electrodes were used. The dark current was ohmic in unsupported films and gap cells, whereas for sandwich cells (10^3 V/cm < E < $5 \cdot 10^5$ V/cm) the voltage dependence was nonlinear. On the basis of this nonlinear voltage dependence the trap density was estimated to be $10^{14}/cm^3$. The room temperature conductivity of DNA dried over P_2O_5 in vacuum was determined to be $\sigma = 10^{-17}$ $(\Omega\ cm)^{-1}$. In sandwich cells a photocurrent was observed that increased linearly with voltage and intensity of illumination. In contrast, exposure of gap cells to uv resulted in a current that could be traced to a photoeffect at the electrodes. The observation on photo and dark conductivities can be interpreted by assuming an energy gap of 6.5 ± 0.5 eV and a donor level at 1.2 ± 0.1 eV below the conduction band. (auth)

41766 STUDIES ON INACTIVATIONS AND RADICAL FORMATION AFTER UV IRRADIATION OF TRYPSIN IN SUSPENSION. Nemec, H. W. (Univ., Freiburg i. B.). Biophysik; 6: 301-14 (1970). (In German).

A method for uv irradiation of suspensions of enzymes in alcohol is described. The uv lamp was dipped into the suspension, which was stirred during irradiation in order to provide a homogeneous exposure of the enzymes and to facilitate the determination of the energy absorbed in the enzymes. The inactivation was studied as a function of exposure time and radical formations were analyzed by way of EPR spectroscopy. The EPR spectra indicated that the oxygen- and water-free suspensions in ethanol provide vacuumlike conditions for uv irradiation. A radical at the C_α position and a sulfur radical of the RS· type were observed. Quantum yields for the inactivation (Φ_i) and for radical formation (Φ_r) were obtained. Irradiation of trypsin at 254 nm yielded $\Phi_i = 2.4 \cdot 10^{-2}$ and $\Phi_r = 1.7 \cdot 10^{-3}$. As a result the value of 0.07 free radicals per inactivated molecule leads to the suggestion that there is no direct relation between the inactivation and the observed radical formation. The same number of free radicals per inactivated molecule was obtained after irradiation with a continuous uv spectrum, the yield of sulfur radicals however was lower than in the 254 nm investigation. Irradiation with $\lambda > 300$ nm partially quenches the radicals produced at 254 nm. (auth)

41767 ROLE OF LYSOSOMES IN CARCINOGENIC PROCESSES AND RADIATION INJURY TO CELLS. Danilov, V. S.; Kozlov, Yu. P.; Tarusov, B. N. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 190: 1474-5(21 Feb 1970). (In Russian).

Lysosome membranes in cells that are suddenly cut off from oxygen or are subjected to ionizing radiation may be destroyed. The integrity of these membranes is regulated by the ATP mechano-chemical system, the enzymatic activity of which depends on the integrity of the protein-lipid complex that may be disturbed by spontaneous oxidative processes initiated by free radicals. These free-radical based processes were studied by chemoluminescence and polarographic techniques, determining the products of peroxidation of lipids. Addition of polycyclic hydrocarbons to the lysosomes resulted in selective interaction processes. Total exposure of animals to γ radiation also caused excitation of lysosomes. At minimal lethal doses the lipids were found to be oxidized, consuming the inhibitors and generating free radicals. These processes probably play an important role in the carcinogenesis and radiation injury of the cells. (TTT)

41768 RADIATION SENSITIVITY OF BACTERIOPHAGE DNA. II. BREAKS AND CROSS-LINKS AFTER IRRADIATION IN VIVO. Bohne, L.; Coquerelle, Th.; Hagen, U. (Institut fuer Strahlenbiologie, Karlsruhe, Ger.). Int. J. Radiat. Biol.; 17: 205-15(1970).

Bacteriophage T1 suspended in aqueous solution of 0.165 M NaCl + 0.1 M histidine was irradiated in a ^{60}Co-γ-source. The inactivation of the plaque-forming ability was followed, and the DNA was isolated after irradiation. The modifications of the DNA structure were studied by means of sedimentation analysis and viscosimetry. The number of the γ-induced double and single-strand breaks as well as the number of cross-links within the phage DNA and of cross-links between DNA and coat protein were calculated. It was shown, that per inactivated phage, 3.5 single-strand breaks, 0.17 double-strand breaks, 0.03 DNA–DNA-cross-links and 0.06 DNA-protein cross-links occurred. (auth) (UK)

41769 STUDIES ON THE HISTOCHEMICAL CHANGES IN EXPERIMENTAL CORNEAL TRAUMA BY ULTRAVIOLET RAYS AND ON THE PREVENTION OF PHOTOPHTHALMIA. Hamerski, Wlodzimierz. Klin. Oczna; 39: 537-42(1969). (In Polish).

During six hours following ultraviolet irradiation, extensive changes appeared in histochemical reactions of the cornea. They concerned mainly the SH groups and SS connections. Distinct changes were also observed in the intensification of the activity of basic phosphatase, acidic phosphatase, adenosin triphosphatase and 5-nucleotidase. Administration of cysteine solution into the conjunctival sac before the irradiation prolonged the symptomless period and alleviated the symptoms of photophthalmia. After the glycerol solution was used the signs of photophthalmia did not appear. (auth)

41770 EFFECTS OF IRRADIATION ON SUB-CELLULAR COMPONENTS. I. LIPID PEROXIDE FORMATION IN THE ENDOPLASMIC RETICULUM. Wills, E. D. (St. Bartholomew's Hospital, London). Int. J. Radiat. Biol.; 17: 217-28(1970).

Suspensions of microsomes prepared from rat liver form lipid peroxide when irradiated in vitro with electron doses within the range 5 to 100 krads. Peroxide formation is minimal immediately after irradiation but increases markedly if the microsomes are incubated at 4°, 20° or 37°C. Dilute microsomal suspensions form much more peroxide than concentrated suspensions. The rate of peroxidation stimulated by NADPH is further enhanced by irradiation. During peroxide formation, extensive degradation of the microsomal lipid occurs with the release of malonaldehyde, or related di-aldehyde, into the aqueous medium. Vitamin E or glutathione (mM) are good protectors against radiation-induced peroxidations. O-phenanthroline (0.5 mM) completely abolishes peroxidation in untreated microsomes, but after doses greater than 50 krads o-phenanthroline has less effect on the rate of peroxidation. ADP contaminated with low concentrations of inorganic iron stimulates peroxidation in untreated microsomes, but has much less effect on irradiated microsomes. In subcomponents of the microsome fraction, the "fluffy layer," composed mainly of membranes of the endoplasmic reticulum, is the main site of peroxidation after irradiation. Peroxidation in microsomal suspensions is likely to be a result of free-radical attack on unsaturated fatty acids, but alterations in the binding of microsomal non-haem iron, increasing its catalytic activity in peroxidation, may also be an important factor. (auth) (UK)

41771 MODIFICATIONS IN SERUM CERULOPLASMIN ACTIVITY AFTER ACUTE WHOLE BODY IRRADIATION. Tomas, E. (Inst. of Inframicrobiology, Bucharest). Atomkernenergie; 16: 77-8(1970).

Whole body x irradiations determine significant increase in rat serum ceruloplasmin activity two hours after irradiation with doses ranging 200 to 600 R. For this interval a dose-response relationship can be observed. Short time after irradiation, a decrease in ceruloplasmin activity occurs that can be correlated with the observed increase in serum citric acid concentration. The results obtained show that there are at least two mechanisms implied in the behavior of ceruloplasmin after irradiation: one unknown and one attributed to catecholamine release. (auth)

41772 STUDY OF THE EFFECTS OF X-IRRADIATION ON THE METABOLISM OF AMPHETAMINE SULFATE AND AMPHETAMINE BENZAMIDE. Noujaim, Antoine Akl. Lafayette, Ind.; Purdue Univ. (1965). 142p.

Thesis.

A study of the effects of x rays on the metabolism of two ^{14}C labeled drugs, amphetamine sulfate and amphetamine benzamide, was the object of this investigation. Mature male rats were x-irradiated with 708 R total acute exposure and injected with one of the drugs after 2, 7, 11, and 21 day periods. The excretion of drug metabolites in the urine was studied for the first through fourth days after injection using liquid scintillation techniques. The metabolites in the urine were separated by thin-layer and thick-layer chromatography. Detection of such metabolites was performed using autoradiography, and the counting of each spot was done through gel-liquid scintillation counting. The effect of x rays on the conjugation of each drug was also investigated. Results indicated that the excretion of both drugs was markedly increased on the 2nd, 11th, and 21st day after administration. This increase amounted to 15, 6, and 10% respectively in the case of amphetamine sulfate, and 15, 22, and 8% respectively in the case of amphetamine benzamide. Both drugs showed a marked irregularity in the pattern of excretion on the 7th day, varying from much below normal to high above normal. The metabolism study of amphetamine sulfate has indicated that unaltered amphetamine, p-hydroxyamphetamine, hippuric acid, and benzoic acid were metabolites of the amine. The latter metabolites were separated by preparative thick-layer chromatography and identified by isotope dilution. This study has also demonstrated that the p-hydroxyamphetamine constituted only 20% of the total activity in the first 24-hr urine, and that other metabolites, more important than the latter, are also excreted. The metabolism of amphetamine sulfate was found to be greatly affected by x irradiation. The amount of free amine excreted was significantly less than the control thus indicating a faster rate of metabolism. The process of hydroxylation was sharply stimulated up to 50% on the 2nd day, 15% on the 11th day, and 30% on the 21st day. The metabolism of amphetamine benzamide has shown that the amide is converted to the amine in the rat. At least 10 metabolites identified by thin-layer chromatography were found in the urine of the animals. Hydroxylation appeared to form a major route of detoxification of the compound. However, another important metabolite constituting about 35% of the total activity was not identified. The process of irradiation appeared to have a cyclic effect on the formation of the various metabolites tested. The conjugation study revealed that amphetamine and its metabolite p-hydroxyamphetamine did not undergo any conjugation in the normal male rats. However, some conjugation appeared in the case of the amphetamine benzamide study thus suggesting a second pathway for the metabolism of the latter. X irradiation had no effect on the conjugation of amphetamine or its studied metabolites, but did cause an increase in conjugation on the 2nd day, and a sharp decrease on the 11th and 21st day in the case of amphetamine benzamide. (Diss. Abstr.)

41773 STUDIES ON THE CHEMICAL BASIS OF CELLULAR RADIOSENSITIZATION BY 5-BROMOURACIL SUBSTITUTION IN DNA. II. PULSE- AND STEADYSTATE RADIOLYSIS OF BROMOURACIL-SUBSTITUTED AND UNSUBSTITUTED DNA. Zimbrick, J. D.; Ward, J. F.; Myers, L. S. Jr. (Univ. of California, Los Angeles). Int. J. Radiat. Biol.; 16: 525-34 (1969).

Pulse- and steady-state radiolysis studies show two major differences in the radiation chemistry of aqueous solutions of E. coli DNA (DNA) and bromouracil substituted DNA (BU-DNA): on exposure of N_2-saturated solutions to low doses of radiation the absorbance of BU-DNA increases while that of DNA decreases; the free radicals formed by OH· attack on BU-DNA decay more rapidly than those on DNA. The differences are explained with the help of results from the accompanying paper by a mechanism involving conversion of the BU moiety of Bu-DNA to a uracil (U) moiety by reaction of BU-DNA with organic free radicals. Uracil-5-yl radicals are formed which may abstract H· from neighbouring deoxyribose moieties to give uracil and radical which may lead to a single-strand break. An hypothesis for BU radiosensitization, based on these and earlier results, account for (a) more DNA base damage and (b) more single-strand breaks in BU-DNA than in DNA; and (c) formation of U in BU-DNA. (auth) (UK)

41774 CELLULAR EFFECTS FROM MICROBEAM IRRADIATION OF BASIDIOBOLUS RANARUM WITH A LASER. Robertson, John L.; Wilson, Charles L. (Univ. of Arkansas, Fayetteville). Mycologia; 62: 227-33(Mar-Apr 1970).

It was possible to cause selective damage to an area as small as 1 μ in diameter within the cell of Basidiobolus ranarum with a laser microbeam without the addition of dyes. Irradiation of the cytoplasm at the tip of the cell often resulted in an arrest of cellular elongation and frequently rupture of the tip. In some cases where nuclei were irradiated during anaphase, smaller nuclei were formed which were capable of division. A single shot into the phragmoplast stopped its development. The destruction of one daughter nucleus also stopped septum formation. The nucleolus appeared to be more sensitive to laser irradiation than the adjacent nuclear sap. A chromosome bridge was observed at mitosis following the irradiation of a resting nucleus. A mutant cell with two tips resulted from the irradiation of a nucleus. (auth)

41775 INCREASED ACTIVITY OF SKIN SURFACE DNASE I AFTER β-IRRADIATION INJURY OR CLIPPING OF GUINEA PIG HAIR. Tabachnick, Joseph; LaBadie, Jon Henry (Albert Einstein Medical Center, Philadelphia). Contract AT(30-1)-3445. J. Invest. Dermatol.; 55: 89-93(Aug 1970).

Small amounts of DNase I can be washed with saline from the guinea pig skin surface immediately after close clipping of hair. Within 24 hr after this relatively mild trauma, there was a 10 to 20 fold increase in skin surface DNase I activity. Two to ten days after 3000 rep β irradiation of the closely clipped skin, both the nonirradiated and irradiated areas had similar increased levels of skin surface DNase I. By the 2nd week or longer, however, the nonirradiated areas had returned toward the low initial values, whereas the irradiated areas (beginning regeneration and repair) maintained a high activity. This increment was not the result of a slow accumulation of enzyme over many days, for after washing the irradiated skin surface of DNase I at these later intervals there was a return to the same high enzyme level within 24 hr. The biological significance and physiologic mechanisms most likely to account for this increase in skin surface DNase I are discussed. (auth)

41776 SURVIVAL, DEOXYRIBONUCLEIC ACID BREAKDOWN, AND SYNTHESIS IN SALMONELLA TYPHIMURIUM AS COMPARED WITH ESCHERICHIA COLI B STRAINS. Hudnik-Plevnik, Tamara A.; Djordjevic, Nadezda (Boris Kidric Inst. of Nuclear Sciences, Belgrade). J. Bacteriol.; 103: 342-7(Aug 1970).

Salmonella typhimurium LT-2 was compared with radioresistant (B/r) and radiosensitive (B_{s-2}) strains of Escherichia coli in respect to the survival, deoxyribonucleic acid (DNA) breakdown, and DNA synthesis after x irradiation. It was shown that S. typhimurium LT-2 was about four times more sensitive than E. coli B/r but less sensitive than B_{s-2}. The DNA breakdown was lower in S. typhimurium LT-2 than the postirradiation breakdown of DNA in both E. coli strains and DNA synthesis proceeded in this bacterium in spite of a much lower survival, as in the radioresistant E. coli B/r. (auth)

Immunology

Refer also to abstracts 41956, 42006, and 42035.

41777 (ORNL-tr-2316) INFLUENCE OF IONIZING RADIATION ON INFECTION AND IMMUNITY. Pritulin, P. I. Translated for Oak Ridge National Lab., Tenn., from Veterinariya; 42: 9-11(1965). 7p. Dep. CFSTI.

The biological mechanisms for protection of the body against pathogenic microorganisms are interdependent and function simultaneously. The effects of ionizing radiation on these barriers are discussed in the light of recent Soviet findings regarding radiation sickness and on the interpretation of results of experiments by the author with Salmonella-carrying organisms (cattle, sheep, and swine) subjected to irradiation. In the carrier experiments, the animals were x-irradiated with a dose of 500 to 600 R higher and the resulting exacerbation and generalization of the process of Salmonellosis analyzed. The following conclusions were noted and discussed. Antibody production was adversely affected, or even in cases where antibodies were already present, the irradiated organisms remained unprotected from infection. Irradiation increased skin and mucous membrane permeability, reduced the bacteriocidal properties of the mucosa, and disturbed the role of the ciliary epithelium of the respiratory mucosa. In x-irradiated guinea pigs, the phagocytic protective mechanism afforded by the macrophages was sharply suppressed. Organisms exposed to ionizing radiation developed septicemia during radiation sickness as a result of the disturbance of the separatory and microbe-destroying function of the reticuloendothelial system. Also, the allergic and anaphylactic reactions of cells were weakened or completely suppressed and the properdin level of the blood dropped sharply or completely disappeared. (E.R.B.)

41778 PROPAGATION OF THE IMMUNE RESPONSE BY CELL TRANSFER. Wakefield, J. D.; Rose, N. R. (State Univ. of New York, Buffalo). Int. Arch. Allergy Appl. Immunol.; 38: 376-93(1970).

Lymphoid cells from 129 Jax/Ha or C_3H/HeHa actively immunized with bovine serum albumin in complete Freund adjuvant were cultured in diffusion chambers or in the peritoneal cavity of non-irradiated and irradiated recipients of selected genotype. High levels of antibody were produced in syngenic recipients for several months and in recipients of diffusion chambers for 4 to 6 weeks. Similar levels of serum antibody were found during the first two weeks in female recipients of male spleen cells. If, however, the diffusion chambers were removed, or if the donor cells were killed by the intervention of a homograft reaction, antibody production in the recipients ceased. Under these conditions; recipients failed to respond to a low challenge dose of BSA used to distinguish a primary from a secondary response. Significant numbers of host cells, therefore, do not acquire specific immunological memory by long standing, close contact with antibody-producing donor cells. (auth)

41779 MECHANISM OF IMMUNOLOGICAL TOLERANCE IN CYCLOPHOSPHAMIDE-TREATED MICE. Many, Amira; Schwartz, R. S. (New England Medical Center Hospitals, Boston. Tufts Univ., Boston). Clin. Exp. Immunol.; 6: 87-99(1970).

The mechanism of immunological tolerance of sheep red blood cells (SRBC) in mice treated with a single dose of cyclophosphamide was studied. Specific tolerance lasted for as long as nine months in some animals, and its maintenance required the repeated administration of SRBC. Anti-SRBC antibody-forming cells were significantly reduced in the tolerant mice, and x-irradiated recipients of their spleens were specifically tolerant of SRBC. The smallest number of SRBC required for the induction of tolerance was 10^7; this was the smallest number of SRBC that could elicit antibody synthesis within 5 days in normal mice. Since the effects of cyclophosphamide on antibody-forming cells last only 5 days, it was concluded that the mechanism of tolerance induction involved destruction of antigen-stimulated cells. In support of this is the finding that mice treated with small doses of cyclophosphamide were rendered tolerant only when SRBC were given before the drug. Drug-induced immunological tolerance thus appears to differ significantly from both pneumococcal polysaccharide paralysis and classical, acquired tolerance. A central loss of immunocompetence does not occur in the former, while the latter requires for its induction the administration of antigen in a dose or form that does not stimulate antibody synthesis. (auth)

41780 APPLICATION OF EXTRACORPOREAL IRRADIATION OF THE BLOOD IN THE TREATMENT OF RENAL HOMOGRAFT REJECTION. Bullimore, A.; Maginn, R. R. (Cambridge Univ., Eng.). pp 133-6 of Progress in Lymphology. II. /Viamonte, Manuel (ed.). New York; Intercontinental Medical Book Corporation (1970).

From 2nd International Congress of Lymphology, Miami Beach, Fla. See CONF-680311.

Extra corporeal irradiation of blood (ECI) proved effective in reversing a case of early or acute rejection of a kidney transplant, which was characterized by a typical mononuclear cell infiltration of the kidney in a human patient. It appeared to have

little or no effect on the late rejection process, which was characterized by an arterial endothelial proliferation. (C.H.)

41781 PARENTAL-F_1 HYBRID BONE MARROW CHIMERAS: HIGH INCIDENCE OF DONOR-TYPE LYMPHOMAS. Cole, Leonard J.; Nowell, Peter C. (Stanford Research Inst., Menlo Park, Calif. Univ. of Pennsylvania, Philadelphia). Proc. Soc. Exp. Biol. Med.; 134: 653-7(Jul 1970).

Adult LAF_1 hybrid mice received a whole-body exposure to 500 R of x rays, followed by a single intravenous injection of 4×10^6 normal, parental strain (A/He) bone marrow cells, which produced no over graft-versus-host morbidity or mortality. On sacrifice 2 yr later, a striking increase in the incidence of malignant lymphoma (76%) over that of appropriate controls, was observed. Transplantation tests with cell suspensions prepared from these lymphomas revealed that they are of donor strain-rather than host-origin. The key point for lymphomagenesis here may be the persistent, tolerated histoincompatibility associated with the parental strain-F_1 hybrid bone marrow cell chimerism, rather than immunosuppression by graft-versus-host reaction. (auth)

41782 HETEROGENEITY OF POPULATIONS OF ANTIBODY-FORMING CELLS FRACTIONATED BY GLASS BEAD COLUMNS. Salerno, A.; Pontieri, G. M. (Univ., Palermo, Italy). Clin. Exp. Immun.; 5: 209-12(Jul 1969).

Spleen cell suspension, obtained from mice immunized 2 to 4 days previously with sheep erythrocytes, was filtered on glass bead columns. The proportion of cells that adhered to the column rose during the first 3 days to about 45%, compared with 8% in controls. This adherent fraction was shown to be relatively rich in antibody-forming cells as judged by immunocyto-adherence. After transfer to lethally irradiated recipients, cells of this fraction formed antibody that was detectable in the serum from 24 hr onwards. Cells of the non-adherent fraction also form antibodies in irradiated recipients, but not before the 4th day after transfer. (auth)

41783 EFFECT OF A SINGLE LARGE DOSE LOCAL X-RAYS ON ALLOGENEIC SKIN GRAFT REJECTION IN THE MOUSE. McCredie, J. A.; Inch, W. R.; Sutherland, R. M.; Vanderkooy, J. (Univ. of Western Ontario, London). J. Surg. Res.; 10: 271-5 (Jun 1970).

A single large dose of x rays was given to the recipient site of a skin allograft or to the established graft to inhibit rejection. Skin from female AKR/J mice was grafted to the interscapular region of C3H/HeJ mice. X rays were given to this area and to the axillary and cervical lymph nodes. The time of 100% graft rejection was determined. Local x rays, 1500 rads, to the established graft at 1, 24, or 72 hr after operation increased survival compared with controls that were sham-irradiated; treatment at 1 hr was most effective. Radiotherapy to the recipient site at 24, 48, or 96 hr before operation increased graft survival compared with controls which were given the same dose to the caudal tissues. There was a rectilinear relation, at doses of 375 to 1500 rads, between the dose of x rays and the day of rejection. Irradiation to two or four limbs, 1000 rads, was as effective as treatment to the graft in the interscapular region. Lymphopenia did not occur. It was concluded that death of lymphocytes was not responsible for the delay in rejection. Radiotherapy to tissues may cause the release of a substance which directly or indirectly inhibits rejection. (auth)

Ecology

Refer also to abstracts 41491, 41743, 41862, 41864, 41865, 41870, 41875, 41886, and 43839.

41784 SYMPOSIUM INTERNATIONAL DE RADIOECOLOGIE, CADARACHE, 8 AU 12 SEPTEMBRE 1969. VOL. II. (Proceedings of International Symposium on Radioecology, Cadarache, France, September 8-12, 1969. Volume 2). Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). 506p. (In French and English). (CONF-690918-(Vol.2)).

Twenty-four papers were presented and separate abstracts were prepared for them. The topics included the effects of natural and fallout radiation and the movement of radioisotopes in various ecosystems. (F.M.M.)

For abstracts of individual papers see: 41738-41745, 41785-41794, 41863-41867, and 41963.

41785 CONTENT AND TRANSLOCATION OF NATURAL RADIOACTIVE ELEMENTS IN THE SYSTEM SOIL-PLANTS-ANIMALS UNDER NATURAL AND EXPERIMENTAL CONDITIONS. Verkhovskaya, I. N. (Inst. of Biochemistry, Moscow); Gruzdev, B. I.; Maslov, V. I.; Vavilov, P. P.; Maslova, K. I.; Nikiforov, V. S.; Ovchenkov, V. J.; Popova, O. N.; Rubtsov, D. M. pp 781-832 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

The migration and distribution of natural radioactive elements in mountain-tundra and taiga biogeocenoses were studied. Radium is intensively absorbed by the plants of the families Rosaceae (Sorbus aucuparia), Ericaceae (Ledum decumbes), Vaccinicaceae (Vaccinium myrtillus, V. vitus idaea, V. uliginosum). Uranium is selectively absorbed by the sporophytes. Thorium has a low biological mobility and does not accumulate very much in plants. Animals play an important part in the transport of radioactive elements beyond the boundaries of sites with high natural radiation backgrounds. No only do they accumulate radioactive elements in their organisms, but they displace huge masses of earth and spread them with their excrements over wide distances. In taiga biogeocenoses, the highest concentrations of radioactive elements are observed in mammals, especially in muriform rodents. (auth) (France)

41786 DIRECT TRANSPORT OF PARTICLE POLLUTANTS FROM ATMOSPHERE TO VEGETAL COMMUNITIES. THEORETICAL CONSIDERATIONS. Belot, Y.; Quinault, J. M.; Caput, C.; Bovard, P. (CEA-CEN, Fontenay-aux-Roses, France). pp 863-81 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

A model of pollutant transport is presented that takes account of the turbulent diffusion within the air layer occupied by the plants and of the particle deposition on the leaf surfaces. An analysis of these mechanisms leads to a system of two simultaneous first-order differential equations, including dimensionless parameters characterizing the vegetal community and the pollutant. These equations were solved numerically for homogeneous crops and plantations in two very simple cases that are further discussed. Numerical solutions are in the form of vertical profiles for the atmospheric concentrations and downward fluxes. These profiles allow an evaluation of the total deposition rate on a vegetal canopy with known characteristics on condition that the underlying assumptions be sufficiently realistic. In the discussion, a number of deficiencies in the theoretical analysis and the experimental knowledge are stated explicitly. (auth) (France)

41787 ROLE OF MURIFORM RODENTS IN THE BIOGENIC MIGRATION OF URANIUM, RADIUM, AND THORIUM UNDER DIFFERENT RADIOECOLOGICAL CONDITIONS. Maslov, V. I. (Academy of Sciences, Syktywkar, USSR); Gruzdev, B. I.; Maslova, K. I.; Nikiforov, V. S.; Verkhovskaya, I. N. pp 923-60 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

The accumulation and transport of natural radioactive elements by animals are studied. The observations made in taiga biogeocenoses on two species of muriform rodents characterized by an intensive digging activity show that these animals not only displace a great amount of radioactive elements but bring them into the surface modifying the environment of their habitat. (auth) (France)

41788 SOME ASPECTS OF RADIOACTIVE FISSION PRODUCTS MIGRATION IN THE FOREST BIOGEOCENOSES AND THE EFFECTS OF IONIZING RADIATIONS ON THE WOODY PLANTS. Alexakhin, R. M.; Karaban, R. T.; Kulikov, N. V.; Molchanov, A. A.; Naryschkin, M. A.; Tarcheskaya, S. V.; Tikhomirov, F. A.; Tyuryukanova, E. B.; Yushkov, P. I. (Academy of Sciences, Moscow). pp 999-1023 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

The distribution and the migration of the most important radioactive fission products in the different types of forest are given. The migration of radionuclides in different components of forest biogeocenoses is discussed. The distribution of global fallout over the forests of the USSR is reviewed. The effects of ionizing radiations on woody plants are also described. (auth) (France)

41789 PRESENT SITUATION REGARDING THE ACCUMULATION OF ^{137}Cs IN FINNISH LAPPS. Rahola, Tua; Hattula, Tuulikki; Miettinen, J. K. (Univ. of Helsinki). pp 1039-56 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

In the nutrient deficient, barren regions of Finnish Lapland a special food-chain mechanism, lichen-reindeer-man, operates. In Scandinavia the Lapps are the greatest consumers of reindeer meat and therefore have maximum radiation burdens from dietary source. Since 1961 a mobile whole-body counter has been used annually to measure a group of about 100 Lapps. The mean maximum whole-body burden for men was found in 1965 to be 1.5 μCi. In 1969 the mean body burden for male reindeer herders was 0.6 μCi. The decrease of the ^{137}Cs values for reindeer and Lapps shows an effective half-time of about 4 years. The annual radiation dose of reindeer herders from ^{137}Cs in 1968 was about 75 mrem/y. The integrated dose to the present generation (1955 to 1985) is 1 rem/30 y, while that of southern Finns is about 25 mrem/30 y. (auth) (France)

41790 NATURAL ACTIVITY AND FISSION-PRODUCT CONTAMINATION OF THE ENVIRONMENT AND OF THE FOOD CHAIN ON SERBIAN TERRITORY FROM 1961 TO 1968. Radovanovic, R.; Brnovic, R.; Moracic, Lj.; Panov, D.; Vukotic, M.; Hajdukovic, D. (Inst. of Occupational Health and Radiological Protection, Belgrade). pp 1065-82 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

The results of radioactivity measurements on drinking water, food and bone are given; the concentrations of ^{210}Pb, uranium and ^{226}Ra were determined on the same samples. The results of measurements of the natural γ radiation doses in Serbian territory are also given. Significant differences were found to exist between the internal contaminations of the inhabitants of different regions. Since 1961 many samples of the environment have been collected on the territory of Serbia for the purpose of studying the passage of ^{137}Cs and ^{90}Sr through a large part of the food chain. During the period between 1962 and 1968, activities of 43 mCi/km^2 ^{90}Sr and 72 mCi/km^2 ^{137}Cs were deposited in Serbia by atmospheric fallout. From measurements of the ^{90}Sr and ^{137}Cs concentration in samples of soil, plants, milk, meat and bones, the transfer coefficients characteristic of the biological chain on Serbian territory were calculated. ^{137}Cs is measured by γ spectrometry. ^{90}Sr is determined by oxalic precipitations of alkaline earths. The ^{90}Y activity is measured by the use of $Al(OH)_3$ as carrier for $^{90}Y(OH)_3$. (auth) (France)

41791 HELOPHYTE PLANTS: A BIOINDICATOR OF RADIOACTIVE CONTAMINATION. Chamel, A. (CEA-CEN, Grenoble, France); Fourcy, A.; Pautou, G. pp 1083-1101 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

Helophytes (biological type "reed") are represented by several species of different ecology. They have a rather high concentration factor and play a prominent part as bioindicator for estimating radioactive contamination of continental waters. The concentration factor was evaluated by experimental contamination (Phragmites) and by radioactivation of stable elements (Baldingera and Arundo), this last genus allowing an extension of the results to the Mediterranean region. (auth) (France)

41792 CARTOGRAPHICAL REPRESENTATION OF NATURAL BIOLOGICAL SYSTEMS: ITS APPLICATIONS IN RADIOECOLOGY. Ozenda, Paul (CEA-CEN, Grenoble, France). pp 1105-17 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

An ecological mapping study was carried out on a sector of the Basse-Isère region downstream from Grenoble. The work was performed in four successive stages: a very detailed analysis of the flora; a graphical and statistical correlation between the various plant groups already defined and the characteristics of the corresponding water tables; a complete, detailed cartographical survey of the plant groups; a map of the zones of influence of the Isère Waters. A possible extension of the method to other similar sites is under consideration. (auth) (France)

41793 FIRST RESULTS ON THE EFFECTS OF GAMMA IRRADIATION ON A MEDITERRANEAN-TYPE ECOSYSTEM. Bovard, P.; Grauby, A.; Tchernia, F. (CEA-CEN, Cadarache, France). pp 1119-35 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

The long-term influence of massive and constant γ irradiation on a particular ecosystem is studied. Observations are made on the somatic and physiological changes that take place in living species and also on modifications to the ecological balance. An attempt will be made to analyze the mechanisms involved in the radiosensitivity inequalities observed. Research will be directed towards cytological studies and towards biochemical studies concerning, for instance, the presence in plant species of substances liable to have a radioprotective effect. The means employed are described and the characteristics of the ecosystem given. (auth) (France)

41794 CHRONIC LOW-LEVEL GAMMA IRRADIATION OF A DESERT ECOSYSTEM FOR FIVE YEARS. French, N. R. (Univ. of California, Los Angeles). pp 1151-67 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

Populations of vertebrate animals, certain insects, and plants were studied in three enclosed 8-hectare areas located in the Mojave desert. They were enclosed by a fence to prevent rodents from entering or leaving the study areas. One area was irradiated almost continuously at a dose rate of 80 to 500 mr/hr. Animal populations were examined by capturing, marking and releasing individuals. Plants were examined for growth and for production of leaves, flowers, fruit, and seeds. The life span of the population of pocket mice, Perognathus formosus, in the irradiated area was shorter than in the other areas. No difference was detected in the numbers of a small lizard, Uta stansburiana, that survived from year to year. Females of a larger but less numerous species of lizard became sterile in the irradiated area. All vertebrate animals in the irradiated area received exposures of 1 to 2R/day. Certain species of plants produced fewer flowers and fruits in the irradiated area. Plants received exposures of 4 to 7R/day. Although wild populations of small mammals are surprisingly sensitive to damage from chronic low-level radiation exposure, they are evidently able to persist under these conditions. There may be certain compensating mechanisms that become operative when the population is subjected to radiation stress. (auth) (France)

41795 RADIOACTIVE CONTAMINATION OF A COCCOLITHOPHORA SP. CLONE WITH ^{54}Mn (ON 12 WEEKS EXPERIMENTS). Ehrhardt, J. P.; Niaussat, P. (CRSSA, Paris). Compt. Rend. Soc. Biol.; 163: 1491-4(1969). (In French).

In a study on the essentiality of Mn for phytoplankton use was made of the radioisotope ^{54}Mn as tracer. Cultures of Coccolithophora sp., a common unicellular marine alga belonging to the Chrysophyta, were inoculated with 6μCi ^{54}Mn per 100 ml using 12 mg $MnCl_2 \cdot 4H_2O$ as carrier. Other cultures were made with the carrier alone and controls were free of Mn. During an observation time of 84 days each day a sample of 2 cc was taken, the algal substance separated from the culture medium by millipore filter, and its activity measured with a NaI crystal to which a 100 channel selector was attached. Data were taken for total activity (Rg), cell activity (Rc) and the difference gave the activity of the cell-free medium (Rm). The concentration rate of algal activity attained after 14 days the equilibrium value of 3.30. It was found that in a culture of Coccolithophora sp. containing 60,000 times as much Mn as seawater the algal cells showed after 2 weeks an Mn concentration three times as great as that of the medium. The absorption velocity in the first 2 weeks is so great that 94% of the total acceptable amount of Mn is assimilated and 66% is taken up in the first 24 hours. (F.J.W.)

Genetics and Cytogenetics

Refer also to abstracts 41754, 41759, 41760, 41948, 41957, 42029, 42031, 42034, 42039, and 42040.

41796 (ANL-7635, pp 162-85) MICROBIAL GENETICS. (Argonne National Lab., Ill.).

Coliphage T4D was cultured in a medium containing methyl-^{3}H-thymidine for studies on appearance of phage binding sites during the cell cycle of Escherichia coli. Radioactivities of cell samples of E. coli and graphs are presented to show results of five phage-binding experiments. The phage-associated radioactivity bound per cell remained essentially constant for approximately the first two-thirds of the cell cycle. Experiments on the growth-duplication cycle of Escherichia coli showed that growth rates remain constant for at least two generation times in cells that are prevented from DNA synthesis and cell division

by thymine starvation and that these growth rates are equal to those of cells in the steady state growth-duplication cycle. After exposure of Escherichia coli to ultraviolet radiation, both lethal lesions and mutational lesions were repaired when chemostat cells were exposed to visible light. It appears that pyrimidine dimers are responsible both for death and mutation. However, repair systems for death and mutation must be different because lethal lesions to phage T5 were not. The diamines, spermine, and cadaverine, were found to be antimutagenic against caffeine induced mutation in chemostat cultures of Escherichia coli. Investigations on nuclear selection showed that filamentous bacteria formed in tryptophan limited cultures have only a single functional nucleus. Two models were proposed for expression of mutation to phage T5 resistance; the delay periods predicted by these models are in agreement with experimental results. Changes in the mean cell volume of E. coli after phage infection were studied and it was noted that swelling of the host cell was a significant stage in the infective cycle of E. coli phage. Experiments were carried out on radiosensitive and radioresistant strains of E. coli; it was found that cell size, age, and the presence or absence of DNA synthesis had no apparent effect on the uv survival curve. A comparison of the lethal effects of ^{32}P and ^{33}P decay in bacteria and bacteriophage showed no difference between the two isotopes. The study of the lethal effects of ^{125}I decay on the DNA of bacteria and bacteriophage showed that ^{125}I decays are approximately ten times more efficient in killing microorganisms than are ^{32}P decays. Bacterial chromosome studies showed that regulation of chromosome replication in Bacillus subtilis, Strain 168, in response to amino acid starvation was different from that in E. coli. Cells were transferred to a medium containing D_2O to obtain DNA for identifying replicating parts of the chromosome. Additional studies on the chromosome in competent cells of B. subtilis involved collecting the cells on a Millipore filter and washing them in a medium containing D_2O. To analyze relative rates of DNA synthesis in competent and noncompetent cells, they were exposed to tritium-labeled thymidine before separation on Renografin. Tables are presented to show genetic maps that present the order in which the markers replicate. It was concluded that competent cells of B. subtilis contain one chromosome that is half-replicated and another that is fully replicated. (H.L.W.)

41797 (BRH/DBE-70-1, pp 17-22) GENETIC STUDIES SECTION. (Public Health Service, Rockville, Md.).

The Genetics Studies section examined the genetic effects of radiation in human populations with emphasis on long-term investigations of successive generations. The possible association between increased infant mortality and fallout was evaluated. A follow-up study was made of the incidence of leukemia in patients who had been treated with ^{131}I for hyperthroidism. No increase was observed in leukemia incidence; however, the risk of development of benign thyroid neoplasms was increased. Effects of x radiation on the human fetus exposed in the early stages of pregnancy were studied. Studies were made on the development of benign and malignant thyroid neoplasms in children following the diagnostic use of ^{131}I. A five-year pilot study of the feasibility of maintaining a registry of all physicians enrolled in the American College of Radiology and the College of American Pathologists was completed. A study was made of the correlation between mongolism in children and parental exposure to radiation. (H.L.W.)

41798 (BRH/DBE-70-1, pp 173-204) GENETIC STUDIES SECTION. (Public Health Service, Rockville, Md.).

Genetic studies included chromosome analysis of personnel with body burdens of mixed radioisotopes; x-ray effects on the nucleolus and on its role in chromosome distribution; the reversal of mitotic effects of colcemid in cultures of human peripheral lymphocytes; electron microscopy of chromosomes from patients with aplastic anemia; ultrastructure of the x-irradiated human chromosome; scanning electron microscopy of human and Chinese hamster chromosomes; effects of 2450 MHz microwave radiation on cultivated rat kangaroo cells; genetics of Drosophila melanogaster exposed to 2450 MHz microwave radiation; chromosome analysis of rat mammary tumor cells in culture; radiosensitivity of haploid and diploid rat kangaroo cells cultured from corneal endothelium; observations on cell cultures from adult Chinese hamsters; unusual chromosome constitution in a family of cats; modifications of x-ray induced cell death by drugs; a microtechnique for Chinese hamster blood cultures; and in vitro meiosis of Chinese and golden hamster oocytes. (H.L.W.)

41799 (STI/DOC-10/86) RICE BREEDING WITH INDUCED MUTATIONS. Technical Reports Series No. 86. Report of an FAO/IAEA Research Co-ordination Meeting Held in Taipei, Republic of China, 5-9 June 1967. (International Atomic Energy Agency, Vienna (Austria)). Jun 1968. 160p. (CONF-670670). IAEA $3.50.

Scientists from nine countries and three international organizations attended the research coordination meeting. Thirteen papers were presented covering various aspects of induction of mutations in rice and their use in breeding programs. Separate abstracts have been prepared for 12 of these papers. (M.M.B.)

For abstracts of individual papers see: 41802-41813.

41800 (STI/PUB-231) INDUCED MUTATIONS IN PLANTS. Proceedings Series. Proceedings of a Symposium on the Nature, Induction, and Utilization of Mutations in Plants Held at Pullman, Wash., 14-18 July 1969. (International Atomic Energy Agency, Vienna (Austria)). Dec 1969. 760p. (In several languages). (CONF-690703). IAEA $20.00.

Separate abstracts were prepared for 45 of the 60 papers appearing in these proceedings. One of the remaining papers, Potential Use of Target Atom Irradiation in Control of Mutation Induction, appeared previously in abstract form in NSA. Two of the remaining papers are opening statements to the symposium, and one paper is a brief survey of the symposium. The remaining 11 papers, which discuss various aspects of chemical mutagenesis, are out of scope for NSA. (E.R.B.)

For abstracts of individual papers see: 41814-41854, and 42027-42030.

41801 EFFECTS OF X RAYS ON GENETIC LOADS IN A CAGE POPULATION OF DROSOPHILA MELANOGASTER. Tobari, Izuo; Murata, Motoi (National Inst. of Radiological Sciences, Chiba, Japan). Genetics; 65: 107-19(May 1970).

The random load, A, and the inbreeding load, B, proposed by Morton, Crow, and Muller (1956), and the frequency of lethal second chromosomes in a population of D. melanogaster, which was irradiated with a dose of 5,000R of x rays in every generation, were examined. The random load, A, was significantly increased by irradiation. It first increased rapidly and then gradually approached the equilibrium value, which was estimated to be 0.512. The inbreeding load, B, was strongly affected by radiation and increased with an increase in dose, although the rate of increase in B-value tended to decrease as the dose increased. According to the theoretical analysis of the data, the equilibrium value of B was estimated to be 1.56, being about four times the magnitude of the inbreeding load in the nonirradiated population. The heterozygous effects of radioinduced mutations, which contributed to the random load and inbreeding load, are also estimated to be 0.296 and 0.126. It was clearly shown that x irradiation brought about a fairly rapid increase in the frequency of lethal second chromosomes. However, the relation between the frequency and the accumulated dose of x rays was curvilinear similar to that for genetic loads. On the basis of the theoretical analysis of the data, the heterozygous effect of lethal genes induced by radiation was estimated to be 0.073. The results obtained in this study indicate that most of the mutations induced by ionizing radiation are deleterious on the average in the heterozygous condition. (auth)

41802 MUTATION INDUCTION IN RICE BY RADIATION COMBINED WITH CHEMICAL PROTECTANTS AND MUTAGENS. Ando, A. (Univ. of Sao Paulo, Brazil). pp 7-15 of Rice Breeding with Induced Mutations. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Induced Mutations in Rice Breeding, Taipei, China. See STI/DOC-10/86; CONF-670670.

The effects of several mutagens with and without chemical protectants were tested on the Brazilian rice variety "Dourado Precoce." Various combinations of gamma radiation, cysteine, and ethylene oxide or ethyleneimine were used. Germination, seedling height, survival, fertility, and chlorophyll mutation rates were measured. Other experiments combined gamma radiation with glutathione or cysteamine, and diethyl sulfate or ethyl methanesulfonate. It was concluded that additional experiments will be necessary before the significance of the results can be judged. (M.M.B.)

41803 INDUCED MUTATION BREEDING OF RICE IN THE REPUBLIC OF CHINA. Li, H. W.; Hu, C. H.; Wu, H. P. (Inst. of Botany, Taipei, Taiwan). pp 17-24 of Rice Breeding with Induced Mutations. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Induced Mutations in Rice Breeding, Taipei, China. See STI/DOC-10/86; CONF-670670.

Work is in progress to obtain stiff-strawed, short-statured rice highly responsive to nitrogen fertilizer, early-maturing types which retain good yields, and new varieties resistant to diseases. Five batches of seeds, including indica and japoica varieties were treated with gamma radiation, x radiation, or thermal neutrons. Regional testing of mutants derived from these seeds and of hybrids

with mutants in their parentage are described. Irradiation of important Chinese varieties and the performance of their segregating progeny are reported. (M.M.B.)

41804 INDUCED MUTATIONS IN RELATION TO THE BREEDING AND PHYLOGENETIC DIFFERENTIATION OF ORYZA SATIVA. Siddiq, E. A.; Swaminathan, M. S. (Indian Agricultural Research Inst., New Delhi). pp 25-51 of Rice Breeding with Induced Mutations. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Induced Mutations in Rice Breeding, Taipei, China. See STI/DOC-10/86; CONF-670670.

Rice, Oryza sativa L. is generally recognized to comprise three major sub-specific categories: indica, japonica and javanica. Under the co-ordinated mutation breeding programme initiated in 1965, three varieties, Taichung Native-1 in indica, Taichung-65 in japonica and Baok in javanica were treated with a wide range of doses of physical (x-rays, gamma-rays and neutrons) and chemical (ethyl methane sulphonate and nitrosomethyl urea) mutagens. Judged by survival and LD-50 growth inhibition, the indica variety was more resistant to both physical and chemical mutagens, as compared with the japonica and javanica strains. The principal findings are summarized below: (1) NMU caused the greatest reduction in germination and survival in the M_1 generation. Chromosome aberrations occurred at a much lower frequency in the chemical treatments compared with irradiated material. Seed fertility was reduced at higher doses of gamma rays and EMS. (2) An exponential increase in the frequency of chlorophyll mutations with an increase in dose and a decrease in the percentage of survival of M_1 plants was noted in the M_2 generation, both for radiations and chemical mutagens. The spectrum of chlorophyll mutations was independent of the mutagens used. (3) A wide spectrum of viable mutations occurred in M_2, particularly in EMS treatments. The spectrum was similar in the indica and japonica varieties, although the relative frequency of different types of mutations was different. (4) The mutation frequency in M_3 from families containing mutations in M_2 was much greater than from families not segregating for mutations in M_2, suggesting that rice behaves more like a diploid in this respect. (5) Mutants with indica type of grains in Taichung-65 and japonica type of grains in Taichung Native No. 1 occurred in EMS treatments. Such mutants are both of economic and phylogenetic interest. (6) Neutron irradiation was the most efficient physical mutagen and nitrosomethyl urea was the most efficient chemical mutagen. (auth)

41805 RADIATION-INDUCED MUTATIONS IN RICE. AN ANALYSIS OF MUTATIONS INDUCED BY CHRONIC GAMMA-RAY EXPOSURE. Tanaka, S. (Inst. of Radiation Breeding, Ibaraki, Japan). pp 53-64 of Rice Breeding with Induced Mutations. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Induced Mutations in Rice Breeding, Taipei, China. See STI/DOC-10/86; CONF-670670.

This paper describes the kind and nature of mutations induced in rice plants by chronic exposures to gamma rays. The agronomic characters, such as length of culm and panicle, weight of panicle and grain, and heading date of mutant lines, which were observed from R_3 generation, were investigated. The total number of mutants investigated was 4461 in 1405 mutant lines, and most of the mutants observed were identified as a concurrent change of more than two characters. The induced mutant lines are classified, their characteristics, frequency of induction, and some correlations between characters are analysed. Finally, mutants are evaluated in relation to mutation breeding in rice plants. In addition, some drastic mutations similar to spontaneous mutations are also described. (auth)

41806 ARTIFICIAL INDUCTION OF BLAST-RESISTANT MUTATIONS IN RICE. Yamasaki, Y. (Nihon Univ., Tokyo); Kawai, T. pp 65-73 of Rice Breeding with Induced Mutations. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Induced Mutations in Rice Breeding, Taipei, China. See STI/DOC-10/86; CONF-670670.

Investigation of the frequency and nature of blast-resistant mutations in rice was made. The effects of radiation on the pathogenicity of the blast fungus were also studied. The frequency of blast-resistant mutants resulting from γ irradiation (10 to 30 kR) of seeds was about one per 1000 M_2 strains, ignoring differences due to dosage. Treatment of seeds with ethyl methanesulfonate resulted in 3 blast-resistant mutants in 600 strains. Stock mutant strains which had been induced by treating seed with ^{32}P, x and γ radiation, and pile neutrons, and treating of the proembryo with x radiation, were tested for blast resistance and two out of 888 were moderately resistant. Growing plants were exposed to chronic γ irradiation for 8 and 28 days from meiosis to heading and from pre-meiosis to post-fertilization, respectively. Total doses ranged from 4 to 32 kR. The frequency of mutation appeared to be about one in 30,000 gametes. Spore suspensions of a blast fungus were exposed to 40, 60, and 80 kR of x radiation. Surviving fungus was sprayed onto various varieties of blast resistant and susceptible rice strains. Some of the fungus strains had increased virulence. Fungus spores were x irradiated with 53 to 61 kR. Eleven out of 2052 surviving strains had decreased in pathogenicity for a susceptible rice variety. (M.M.B.)

41807 EVOLUTION OF NEW RICE VARIETIES BY INDUCED MATATIONS TO INCREASE YIELD AND RESISTANCE TO DISEASES AND TO IMPROVE SEED QUALITY. Miah, A. J.; Bhatti, I. M. (Atomic Energy Agricultural Research Center, Tandojam, Pakistan). pp 75-96 of Rice Breeding with Induced Mutations. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Induced Mutations in Rice Breeding, Taipei, China. See STI/DOC-10/86; CONF-670670.

Seeds of two indica rice varieties namely, Kangni-27 (a coarse variety) and Dokri Basmati (a fine variety) were irradiated with 20, 25, 30, 35, 40, 45 and 50 kR of gamma rays from a 13000-Ci ^{60}Co source. In the M_1 generation (1964), germination percentage, seedling height and seed fertility were studied. The data indicated that Kangni-27 is more radioresistant than Dokri Basmati. In the M_2 generation (1965) two polygenic traits, i.e. leaf size and grains per unit length were studied. From the analysis of the data it was found that variability was greater in the irradiated populations than in the non-irradiated controls. Apart from the study of the polygenic traits, several mutants which appeared to be useful to the breeder (e.g. dwarf, short-culm and early flowering) were isolated from the irradiated populations of Kangni-27. In the M_3 generation (1966) several agronomically important characters were studied in all the mutants isolated in the M_2 generation. It was noticed that the mean values of most of the characters of all the mutants deviated from the mean values of the respective controls. These deviations were both negative and positive. Further analysis is in progress. Three more experiments were started, two in the year 1965 on the effects of gamma rays and one in 1966 to compare the effects of EMS and gamma rays. (auth)

41808 BREEDING OF EARLY, HIGH-YIELDING DISEASE-RESISTANT RICE VARIETIES. Haq, M. S. (Atomic Energy Center, Dacca, Pakistan). pp 97-8 of Rice Breeding with Induced Mutations. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Induced Mutations in Rice Breeding, Taipei, China. See STI/DOC-10/86; CONF-670670.

The initiation of a breeding program for high-yielding, disease resistant rice is described. Seeds of two varieties were γ-irradiated with 30 kR from a cobalt-60 source. Plants grown from these seeds were examined for height and number of panicles. (M.M.B.)

41809 STUDIES ON INDUCTION OF MUTATIONS IN RICE. THEIR NATURE AND USE FOR RICE IMPROVEMENT. Viado, G. B. (Philippine Atomic Energy Commission, Manila). pp 99-108 of Rice Breeding with Induced Mutations. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Induced Mutations in Rice Breeding, Taipei, China. See STI/DOC-10/86; CONF-670670.

Various mutagens were used for treatment of seeds of Philippine rice varieties. The ratio of viable to lethal mutations after treatment with ethyl methanesufonate (EMS) was 2.5 to 1. A linear dose-effect was obtained for seedling height, somatic mutation frequency, and M_1 fertility. Treatments before and after γ irradiation of seeds were tested for their effect on chromosomal damage and mutation rate. Moisture content of seeds before irradiation of less than 14% increased seed damage and lowered the mutation yield. Storage and irradiation in a nitrogen atmosphere decreased damage and increased mutation yield. Hulled seeds had higher germination but no difference in mutation rate. Rehydration after irradiation reduced damage but not if done in oxygen. Post-treatment washing for 4 hr of EMS-treated seeds increased the M_2 mutation frequency but longer washing destroyed the endosperm. Seedling height reduction after γ irradiation was greater for dry than for moist (14%) seeds. Treatment with EMS showed a dose-effect for seedling height reduction. Gamma and mixed radiations increased the percentage sterility in four varieties but not in Raminad strain 3. EMS-treatment increased sterility in BPI-121 but reduced it in four other strains. Mutants derived from treated plants are being used for further studies. (M.M.B.)

41810 INDUCTION OF MUTATIONS IN THAI RICE VARIETIES AND SUBSEQUENT SELECTION AND TESTING OF BENEFICIAL MUTANT LINES. Dasananda, Sala; Lusanandana, Bhakdi; Prongsiriwathana, Chamras; Khambanonda, Pricha (Ministry of Agriculture, Bangkok). pp 109-13 of Rice Breeding with Induced Mutations. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Induced Mutations in Rice Breeding, Taipei, China. See STI/DOC-10/86; CONF-670670.

Radioinduced mutation studies, started in 1955, are reviewed. A program, still in progress, was initiated in 1964 to obtain beneficial mutants for breeding. Various rice varieties were treated with cobalt-60 γ irradiation or with ethyl methanesulfonate. Data are presented on height and flowering dates for M_3 plants selected from the irradiated lines. (M.M.B.)

41811 RICE BREEDING PROBLEMS IN KOREA. Ree, J. H. (Yungnam Crop Experiment Station, Milyang, Korea). pp 119–25 of Rice Breeding with Induced Mutations. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Induced Mutations in Rice Breeding, Taipei, China. See STI/DOC–10/86; CONF-670670.

General rice production in Korea and the problems encountered are discussed. The history of rice growing and breeding in Korea is outlined, and a description of recent advances in rice breeding is given, including a discussion of some uses of radiation treatments in the breeding programme during the last few years. (auth)

41812 EXPERIMENTS WITH MUTAGEN TREATMENTS OF RICE. Mikaelsen, K.; Navaratna, S. K. (International Atomic Energy Agency, Vienna). pp 127–32 of Rice Breeding with Induced Mutations. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Induced Mutations in Rice Breeding, Taipei, China. See STI/DOC–10/86; CONF-670670.

Experiments were carried out with rice and barley to study the effects of ionizing radiations and chemical mutagens on the basis of seedling growth reduction. The effects of the chemical mutagens ethyl methane sulphonate (EMS) and diethyl sulphate (dES) were studied. A new method for the application of chemical mutagens in rice was developed. The radiosensitivity of dormant rice and barley seeds to gamma radiation and fast neutrons was compared. The dose required to produce 50% reduction in rice was 10 times higher with gamma radiations than with fast neutrons. This ratio for barley was 37 : 1. (auth)

41813 SUMMARY OF OBSERVATIONS FROM THE FAO/IAEA/IRRI UNIFORM REGIONAL RICE MUTANT TRIALS 1966/1967. pp 139–52 of Rice Breeding with Induced Mutations. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Induced Mutations in Rice Breeding, Taipei, China. See STI/DOC–10/86; CONF-670670.

At the Second FAO/IAEA Co-ordinated Meeting of Research on the Use of Induced Mutations in Rice Breeding held in Manila from 21 to 25 February, 1966, it was proposed that a comparison be made of promising mutants from various sources. The final resolution was expanded to include a series of co-ordinated trials which were aimed to evaluate on a regional basis those mutant progenies that have been reported to possess certain features superior to their parent varieties, and to compare them with promising parental or non-parental varieties and selections from conventional hybridization programs. The Geneticist of The International Rice Research Institute was nominated as the technical co-ordinator in assembling and disseminating seed material, designing field record books and co-ordinating research activities in close liaison with the IAEA officers in Vienna. (auth)

41814 A STUDY ON INDUCED MUTATIONS IN PLANTS. Gustafsson, A. (Univ. of Lund, Sweden). pp 9–31 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB–231; CONF-690703.

A brief summary is presented of the historical development of radiation genetics. A discussion is given of the contributions of various investigators to the following: chemical mutagenesis; the concepts of oligogenes and polygenes and their effects on crop plants; the use of radioinduced mutations and recombinations in plant breeding; improved methods of induction, screening, and selection for utilization of induced mutations; and chemico-physiological alterations by induced mutation. (H.L.W.)

41815 STRUCTURAL AND BIOCHEMICAL CONCEPTS OF MUTATIONS IN FLOWERING PLANTS. Nilan, R. A.; Kleinhofs, A.; Sideris, E. G. (Washington State Univ., Pullman). pp 35–49 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB–231; CONF-690703.

Advances in knowledge of the nature of mutations, especially in flowering plants, since the first symposium on induced mutations in plants was held in Rome in 1964 are reviewed. The subjects treated are: extragenic or "chromosome" mutations; "point" or gene mutations; possible intragenic events; and extrachromosomal mutations. A comprehensive list of references is included. (auth)

41816 MUTATION AND REPAIR IN EUGLENA GRACILIS. Olson, A. O. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 61–9 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969). (AECL–3334).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB–231; CONF-690703.

The ability of the Euglena nucleus to survive mutagenic treatments that cause permanent apochlorosis suggests that the nucleus must possess a much more efficient repair system than do the chloroplasts. An excision mechanism capable of removing nucleic acid bases modified by N-methyl-N-nitroso compounds (i.e. N-methyl-N-nitro-N-nitrosoguanidine) is demonstrated. From studies with light synchronized cells, and with extracted chloroplasts, it appears that excision enzymes are not present in Euglena chloroplasts. (auth)

41817 INCREASING THE SPECIFICITY OF MUTATION. Brock, R. D. (Commonwealth Scientific and Industrial Research Organization, Canberra, Australia). pp 93–100 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB–231; CONF-690703.

Two sets of experiments were undertaken with the object of increasing the specificity of the mutation process. The first of these was aimed at locating mutagens to mutate active loci in preference to inactive loci and the second at inducing mutations via the regulator protein which is locus specific. Mutation of active versus inactive loci: With the β-galactosidase locus of Escherichia coli, where the gene can be held in an active (induced) or inactive (non-induced) state while replication is inhibited, a range of mutagenic agents have been tested. Certain mutagens, i.e. DES, EMS, NG, have been shown to mutate the active gene with a higher frequency than the inactive gene. Other mutagens, e.g. γ-rays, have the same mutagenic efficiency for both active and inactive genes. If similar specificity occurs in higher plants, some control of the mutation process should be possible by applying such mutagens when particular genes are active. Mutation at specific loci: Attempts have been made to utilize the DNA-recognizing property of the regulator protein of the lactose operon of E. coli to mutate specifically the operator gene. The regulator protein has been made mutagenic by incorporating ^{35}S or ^{3}H amino acids. The incorporated isotopes act as microirradiation sources. Incorporated ^{35}S or ^{3}H methionine, leucine and valine increase the mutation frequency from 10 to 100 times, while other ^{3}H amino acids do not increase the mutation frequency. This system offers the prospect of specific mutation at loci which are controlled by a regulator protein by isolating the regulator protein, making it mutagenic and reintroducing it into the cell. (auth)

41818 RIBULOSE–DIPHOSPHATE CARBOXYLASE ACTIVITY IN INDUCED BARLEY MUTANTS. Kleinhofs, A. (Washington State Univ., Pullman). pp 101–8 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB–231; CONF-690703.

Radiation and chemical mutagenesis in barley results in a large number of chlorophyll deficient phenotypes. Many of these are probably mutants affecting chloroplast development. The mutants investigated were induced by various chemical and radiation treatments in the homozygous barley variety Himalaya and propagated by selfing for several generations. Seedlings grown under uniform environmental conditions were assayed. No RuDP carboxylase activity has been found in albino mutants tested to date. Large variations in RuDP carboxylase activity have been found in the rest of the mutants. Most of the mutants, as expected, show reduced RuDP carboxylase activity, but some with increased RuDP carboxylase activity have been identified. Since this enzyme is the limiting step in the dark reaction of photosynthesis, which in turn is a limiting step in photosynthesis, a more active enzyme or one with higher affinity for CO_2 should result in a more efficient plant. Possible practical applications of this knowledge as well as problems of selection for specific mutants are discussed. (auth)

41819 RELATIVE EFFECTIVENESS OF PHYSICAL AND CHEMICAL MUTAGENS. Kawai, T. (National Inst. of Agricultural Sciences, Hiratsuka, Japan). pp 137–52 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of

Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

A review of the results of studies on mutagen effectiveness is presented with special stress being laid on the significance of these studies for plant breeding. Among the subjects treated are: chlorophyl mutations, chromosome aberrations, the mutation spectrum, and the yield performance of mutations. A comprehensive list of references is provided. (auth)

41820 INDUCTION OF MUTATIONS IN MUNGBEAN (PHASEOLUS AUREUS ROXB.) AND GENETIC STUDIES OF SOME OF THE MUTANTS. Santos, I. S. (Philippine Atomic Research Center, Manila). pp 169-79 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Ethyl methanesulphonate (EMS) and ^{60}Co gamma rays were used separately to induce mutations in the mungbean. Dry mungbean seeds were soaked for 20 hours at 25°C in an aqueous solution of EMS at concentrations of 0.04 M and 0.05 M. The treated seeds were rinsed and then sown in sterilized sand. The gamma-ray dosages were 60, 100, and 160 kR. In addition, the seeds were subjected to different heat treatment, i.e. no heat treatment, pre-irradiation heat treatment and post-irradiation heat treatment. The moisture content of the seeds at the time of irradiation was approximately 8%. The results of the present study are compatible with the conclusion that there are differences in mutation spectrum among mutagenic agents. In addition, the results of the present study indicate that there might be differences in mutation spectrum between the different gamma-ray dose levels and/or the different types of heat treatment. There were also indications that heat treatment, especially after irradiation, increased mutation frequency. Two leaf mutants are particularly interesting: the unifoliata from the gamma-ray series and the multifoliata from the EMS series. The former mutant is sterile but very vigorous, unlike the weak unifoliata mutant reported by Jana (1962) in Phaseolus mungo L. The multifoliata mutant is very leafy and may be useful as a green manure crop. In addition, even in the M_6 the multifoliata mutant is still susceptible to outcrossing, indicating some pollen sterility or reduced cleistogamy. Several natural outcrosses of this mutant have been obtained which have facilitated the transfer of the mutant gene into different genetic backgrounds. Segregation of a few of the mutants was studied in the M_3 generation. The chlorophyll mutants xantha and variegata and the leaf mutants unifoliata and multifoliata behaved as monogenic recessives. The greenish yellow (chlorina) mutation obtained in the gamma-ray series segregated as a monogenic recessive in three heterozygous M_2 lines, but appeared to be due to two recessive genes in two additional heterozygous M_2 lines. (auth)

41821 GENETIC EFFECTS OF SHORT-TERM GAMMA IRRADIATION AT DIFFERENT DOSE RATES ON BARLEY PLANTS (PIROLINE VARIETY) DURING DEVELOPMENT. Silvy, A.; Pereau-leroy, P. (CEA, Cadarache, France). pp 181-93 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969). (In French).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Barley plants of which the principal meristems were in the process of floral differentiation (from the first outgrowths to the beginning of another formation) were irradiated during their photoperiod for fixed times (30 s, 3 min 45 s, 15 min, 1 h, 4 h and 16 h) at different doses (500 to 1700 rad). The corresponding dose rates were between 70 and 67,200 rad/h. After separation into three categories according to their origin (A-spikes of barley marked before irradiation, B-unmarked spikes with fertility below 50%, and C-unmarked spikes with fertility greater than 50%), the spikes yielded were cultivated for two generations, M_1 and M_2. In the irradiated generation, M_0, the dose rate affects survival of the A meristems, length of the straw and fertility of the spikes. The effects increase with the dose and decrease with the irradiation time: 500 rad in 20 s, 600 rad in 15 min and 1100 rad in 4 h or 16 h all produce equivalent effects. Irradiation has no influence on the germination of M_1 grains. Some chlorophyll mutations occur, especially in category B (1.3% of M_1 plants). Their origin has not been explained. The fertility of the barley spikes is normal for all treatments. In M_2 there is considerable variation in the chlorophyll mutation rate. After elimination of treatments that result in excessively low survival, it is found that the percentage of mutated M_2 plantlets increases with dose and decreases with irradiation time; however, by lengthening the irradiation time one can apply higher doses to the plants. The highest mutation rates are found in category A. The segregation rates in categories A and B are not significantly different from 25%. The advantage of this technique as compared with the treatment of grains and embryos and with long-term irradiation of plants in the development stage is discussed, as are the relative advantages of the different methods for scoring the mutants. (auth)

41822 MUTAGENIC EFFECT OF GAMMA RAYS, DIETHYL SULPHATE, ETHYL METHANESULPHONATE, AND VARIOUS COMBINATIONS OF GAMMA RAYS AND THE CHEMICALS. Doll, H.; Sandfaer, J. (AEC Research Establishment Risoe, Roskilde, Denmark). pp 195-206 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Dormant seeds of the barley variety Carlsberg II were treated with different doses of γ-rays, DES, EMS and combinations of γ-rays and DES or EMS. The survival and the sterility of the M_1 plants were estimated. Some seeds from each M_1 plant were sown in a greenhouse for scoring of chlorophyll mutants. The remaining M_2 seeds were sown in the field and all clearly deviating plants were scored as morphological mutants. Gamma rays were found to combine additively with DES and EMS with respect to M_1 sterility and M_2 mutant frequency. However, the survival frequency of the M_1 plants was reduced more than additively when large doses of γ-rays and DES or EMS were combined. On the basis of the relation between the M_1 sterility and the M_2 mutant frequency, DES was found to have the same mutagenic efficiency as EMS, while γ-rays were considerably less efficient than the two chemicals. Combined treatments with γ-rays and DES or EMS were of intermediate efficiency. The spectrum of chlorophyll mutations induced by γ-rays differed from the spectra obtained after treatment with DES and EMS, which were found to be alike. The three mutagens tested induced approximately the same proportion of chlorophyll mutations and morphological mutations. (auth)

41823 RESPONSES IN MUTATION, GROWTH INHIBITION, TUMORIZATION AND ISOZYME MULTIPLICITY FROM EXPOSING SEEDS TO IRRADIATIONS OF DIFFERENT LINEAR ENERGY TRANSFER. Smith, H. H. (Brookhaven National Lab., Upton, N. Y.); Hirono, Y.; Conklin, M. E.; Lyman, J. T. pp 231-43 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Seeds of a genetic stock of Arabidopsis thaliana and of three genotypes of Nicotiana (two species and their tumour-prone amphiploid) were irradiated. The irradiations ranged in linear energy transfer (LET) from 2 keV/μm (250 kVp x rays) to 1890 keV/μm (argon ions). The responses measured were somatic mutations, tumorization, various manifestations of growth inhibition, and the production of peroxidase isozymes. The relative biological effectiveness (RBE) for all criteria measured, including mutations, was highest at LET's of 74 to 172 keV/μm. This indicated a common primary target – the genetic material – for each effect. The dose of fission neutrons relative to 250 kVp x rays to produce an equal effect (regardless of criteria) maintains a simple power function relationship with a slope of between 1 and 2. As a consequence, the RBE is inversely related to absorbed dose so that genotypes or criteria that are affected by low doses give relatively high RBE's and vice versa. The production of multiple forms (isozymes) of peroxidases is enhanced by irradiation, is dose dependent, is relatively more affected per unit dose by neutrons than by x rays, and provides a readily measurable response to irradiation at a molecular level. (auth)

41824 INFLUENCE OF MITOTIC STAGE ON THE EFFECTIVENESS OF MUTAGEN TREATMENTS. Mikaelsen, K. (International Atomic Energy Agency, Vienna). pp 245-9 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Barley seeds were germinated, exposed to gamma radiation and treated with chemical mutagens (EMS and DES). After the mutagen treatments, germination continued and roots were fixed at various times from 2-24 hours later. The effects of the treatments were studied on chromosome aberrations in anaphase of the root meristematic cells. On comparing the ionizing radiation and the alkylating agents at different fixation times after treatments, it appeared that the highest frequency of chromosome aberrations was obtained four hours after exposure to gamma radiation. For the alkylating agents the highest chromosome aberration frequencies were found 18-21 hours after the treat-

ments. After studying the sensitivity at different mitotic stages, it was concluded from these experiments that G_2 was most sensitive to ionizing radiations, while early G_1 showed the largest sensitivity to EMS and DES. In late G_2 and M almost no damage occurred leading to chromosome breaks appearing in the first mitosis after treatment. (auth)

41825 STUDIES ON MUTATION RATES AND RANGE WITH BASE SPECIFIC CHEMICALS. Jain, H. K.; Khamankar, Y. G.; Shukla, P. T. (Indian Agricultural Research Inst., New Delhi). pp 251-9 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Chemical mutagens such as hydrazine and hydroxylamine, whose action can be interpreted in terms of molecular mechanisms, have been known to induce mutations in micro-organisms. Hydrazine reacts with the DNA base thymine under particular conditions of treatment, while hydroxylamine attacks the base cytosine. The action of these two mutagens and of gamma rays has been studied in Lycopersicon, following the specific locus method. It has been found that a number of gene loci are extremely sensitive to these mutagens, giving mutation rates seldom obtained with ionizing radiation and other mutagens. Thus, homozygous recessive mutants could be consistently isolated for a number of genes in the M_1 generation, following treatment of seeds under properly controlled conditions. The mutants have continued to breed true for several generations and tests of allelism with known markers have helped to identify the gene loci involved. The M_1 mutant seedlings, it could be concluded, arise from a simultaneous effect on the locus concerned in both the homologous chromosomes. Although both hydrazine and hydroxylamine have been found to induce mutations, they appeared to be quite selective in their action. Most of the observed mutations were induced by one or the other of the two chemicals and not by both. A gene which was found to be particularly sensitive to hydrazine is d (dwarf seedling), which was little affected by hydroxylamine. None of the gene loci were found to be sensitive to gamma rays. For purposes of comparison, doses of the different mutagens were considered which induced similar seed lethality. The above studies on the effect of two chemical mutagens and ionizing radiation have been extended to Drosophila. The analysis again shows that the mutation spectrum associated with the two mutagens is very different. Eight of the gene loci found to be sensitive to hydroxylamine were little affected by hydrazine. Hydroxylamine, in general, gave higher mutation rates. The analysis as a whole indicates that base specific chemicals offer considerable scope in maximization of mutation rates and that different chemicals induce a different pattern of variability. Notwithstanding the difference in the organization of genetic material in micro- and macro-organisms, these chemicals are effective in both groups. (auth)

41826 EFFECTIVENESS OF MUTAGENIC TREATMENTS WITH IONIZING RADIATION IN BARLEY. Walther, F. (Kernforschungsanlage GmbH, Juelich, Ger.). pp 261-70 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

After application of ionizing radiation to dormant barley seeds the effectiveness of the radiation in inducing genetical changes can be estimated by counting the number of chlorophyll mutations in the M_2 generation. The rate of mutations is calculated as the number of mutations per 100 M_1 plant progenies, per 100 M_1 spike progenies, or as the number of mutants per 100 M_2 plants. Thus the calculation of the rate of mutations is dependent on the number of surviving and spike bearing M_1 plants. In certain respects, however, for mutation breeding it is more important to induce a high number of mutations per 100 treated seeds than per 100 surviving M_1 plants. This is concluded from the fact that the number of mutants per mutation is more or less constant (2-3 mutants per mutation). Extensive variations of this number could be found neither after application of various doses of x rays and thermal neutrons nor with a different genetic background of a number of barley varieties. This is also true for different kinds of chlorophyll mutations. A factor of effectiveness has been calculated: (number of mutations/number of treated seeds) × 100 which indicates the number of mutations per 100 treated seeds. This factor of effectiveness is highest if the number of surviving M_1 generation plants and their fertility is optimal, i.e. there has to be a certain balance between the rate of surviving plants and their remaining fertility. Thus we find thermal neutrons to be more effective than x rays if doses are compared on the basis of rate of survival. (auth)

41827 INDUCED MUTATIONS AND BREEDING METHODS IN VEGETATIVELY PROPAGATED SPECIES. Broertjes, C. (Inst. of Atomic Sciences in Agriculture, Wageningen, Netherlands). pp 325-9 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

A number of factors that determine the possibilities of mutation breeding in vegetatively propagated plants are briefly discussed: the kind of plant material to be irradiated, the genotype of the cultivar involved, the availability of a discriminative selection method, etc. To demonstrate that mutation breeding, under favourable conditions, can very quickly become commercially interesting, work with Streptocarpus "Constant Nymph" is discussed as an example. From this cultivar five commercial mutants were obtained in less than three years, namely "Purple Nymph" (purple flower colour), "Mini Nymph" (compact growth), "Blue Nymph" (light-blue flower colour), "Netta Nymph" (netted and picotee flowers) and "Cobalt Nymph" (dark-blue flowering compact growing tetraploid). (auth)

41828 MUTATION INDUCTION IN THE SWEET POTATO BY MEANS OF FAST-NEUTRON IRRADIATION. Love, J. E. (Louisiana State Univ., Baton Rouge). pp 331-6 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Exposure of sweet potato plants (Ipomoea batas, Poir.) to 0, 300, 600, or 900 rad of unmoderated fission neutrons resulted in several types of somatic mutation. The most obvious changes observed were for skin colour and flesh colour of the roots at the higher levels of exposure. All mutations occurred sectorially within a single root and were perpetuated through asexual reproduction. Skin colour changes of the roots were due to a loss or gain of two anthocyanin pigments, cyanidin-3,5-diglucoside and peonidin-3,5-diglucoside. The ratio of one anthocyanin to the second was not altered through mutation induction. Varieties with no anthocyanin pigments (cream-coloured roots) were not subject to change in skin colour after radiation exposure. All mutations for flesh colour resulted from a loss in the amount of B-carotene, the major pigment of sweet potatoes. Flesh colour mutations were observed for each variety exposed. There appeared to be no relationship between the induction of skin colour changes and the flesh colour mutants. (auth)

41829 EFFECT OF GAMMA RADIATION ON A COMPLEX SIM CARNATION CHIMERA. Pereau-Leroy, P. (CEA, Cadarache, France). pp 337-44 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969). (In French).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Gamma irradiation of cuttings from Jacqueline Sim carnations with red-striped orange flowers leads to the formation of three types of flower on one and the same plant: orange (normal colour), plain red and red-striped yellow. The proportion of each type varies with the dose and the dose rate, and also with the physiological state of the meristems at the time of treatment. Taking samples of cuttings from stems that have borne flowers all of the same colour after the first irradiation, the author produces clones that are then subjected to a second treatment. The stems with yellow or red flowers are found to be genetically homogeneous, whereas those with orange flowers are still chimeras. To explain this phenomenon, the author advances two hypotheses, based on the existence in the Jacqueline variety either of two or of three genetically distinct layers. (auth)

41830 SUCCESSFUL USE OF IRRADIATION BREEDING TO OBTAIN VERTICILLIUM-RESISTANT STRAINS OF PEPPERMINT, MENTHA PIPERITA L. Murray, M. J. (A. M. Todd Co., Kalamazoo, Mich.). pp 345-71 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

In the period 1955-1959, under contract with the Brookhaven National Laboratory, peppermint stolons were irradiated with neutrons and x rays. Despite 25% loss of irradiated plants in greenhouse flats, over 100,000 plants were set in severely wilt-infested soil. This field planting produced more than 6 million plants in the second-year growth, but these were reduced by the subsequent four years of natural selection to about a 1%

stand. 58,724 non-wilt selections were field tested–first as single plants, then in replicated 1.8-m plots and finally in larger plots. This testing program isolated 7 highly wilt-resistant strains with smaller leaves, earlier maturity and a more erect habit; 5 moderately wilt-resistant, very vigorous strains with coarser stems and leaves; and 50 slightly wilt-resistant strains with near-normal appearance. All 5 vigorous strains have irradiation-induced heterosis for herbage weight and the 3 strains adequately tested exhibit heterosis for oil yield. The 6 strains in regional tests in Indiana, Oregon (C. E. Horner and Oregon State University) and Washington (C. B. Skotland and Washington State University) have approximate Mitcham peppermint oil quality and established plantings equalling or exceeding the cultivar in oil yield. Of basic genetic interest, irradiation of multicellular meristems produced a few visible qualitative-like and many quantitative-like micro-mutational changes in M. piperita. Diplontic cellular selection stabilized the genotype in a non-chimeral condition and natural selection acted in either a positive or a negative manner on the induced mutational changes. Specifically, natural selection eliminated in one year almost all mutations producing chlorophyll changes. While the numerous hairy mutants (also known rarely from spontaneous origin) had no obvious selective advantage, they persisted without increasing in numbers. High selection pressure for Verticillium wilt resistance may preserve strains that exhibit great heterosis for vegetative vigour and oil yield, or conversely preserve wilt-resistant strains that are less adapted in other respects. Several strains were less vigorous, one strain was frost susceptible and four were susceptible to insect infestation. Minor quantitative-like mutational changes were abundant in the stabilized strains after 6 years of vegetative propagation, which demonstrates clearly that certain mutations in single somatic cells can be effective in changing the genotype of a sterile vegetatively propagated perennial species. Irradiation breeding can be used effectively in most polyploid species, since they are generally composed of distinctly different genomes with some unduplicated areas. The suggestion is made that irradiation dosages (particularly in vegetatively propagated species) should be high enough to inactivate preformed meristems, thus forcing the development of adventitious shoots which, as Broertjes has shown, are often derived from single cells. (auth)

41831 MICRO-MUTATIONS INFLUENCING YIELD IN BARLEY: STUDIES OVER NINE GENERATIONS. Gaul, H. P. K.; Ulonska, E.; Zum Winkel, C.; Braker, G. (Max-Planck-Institut fuer Zuechtungsforschung, Cologne. Bayerische Landessaatzuchtanstalt, Weihenstephan, Ger.). pp 375-98 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

A summary is presented of studies on populations of micro-mutations in three varieties of barley: with one variety up to the M_9 generation and with the two others up to M_8. These experiments represent a continuation of those up to M_3 reported at the first FAO/IAEA Symposium held in Rome in 1964. The results obtained show that it is relatively easy to select micro-mutations having a yield potential 10% higher than the mother variety. It may be expected that the yield potential can be further raised in a second, third and later cycles of mutagenic treatment and selection. It is suggested that the micro-mutation technique be used for continuous improvement of newly released varieties, particularly of top varieties. If it is combined with maintenance breeding, these varieties may continue their superiority over freshly introduced varieties for a longer period of time. (auth)

41832 STABILIZATION OF INDUCED GENETIC VARIABILITY IN IRRADIATED POPULATIONS OF VULGARE WHEAT. Borojevic, Katarina; Borojevic, S. (The University, Novi Sad, Yugoslavia). pp 399-32 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Genetic variability of the main quantitative characters was studied in several irradiated populations of Triticum aestivum vulgare. The increase in genetic variability induced by treatment was stabilized in M_5-M_6 and left at this level through later generations. Besides the primary induced genetic variability, some new variability appeared in later generations of the irradiated populations. This was also expressed in generations in which induced variability had been stabilized. Analysis of these phenomena is discussed in detail in the paper. (auth)

41833 EFFECT OF RECURRENT THERMAL-NEUTRON AND ETHYL METHANE SULPHONATE SEED TREATMENTS ON GENERAL AND SPECIFIC COMBINING ABILITY FOR PEARL MILLET (PENNISETUM TYPHOIDES) FORAGE YIELDS. Burton, G. W.; Powell, J. B. (Georgia Coastal Plain Experiment Station, Tifton). pp 433-43 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Research was begun in 1962 to study the effect of three cycles of recurrent seed treatment with various dosages of thermal neutrons (TN) and ethyl methane sulfonate (EMS) on general and specific combining ability for forage yield. Pearl millet, Pennisetum typhoides (Burm.) Stapf and C. E. Hubb., a diploid ($2n = 14$) annual grass used for forage in the United States, was chosen for this investigation because: hybrids between certain inbreds exhibit much heterosis for forage yield, studies involving many such hybrids revealed that the genetic variance for forage yield was about equally divided between general and specific combining effects, chromosomal aberrations would not affect forage yields as they might be expected to affect grain yields, and forage yields could be precisely measured (coefficients of variation <10%). Six well-established pearl millet inbreds were chosen for the investigation. Mutagen dosage efficiency was monitored by ascertaining the frequency of chlorophyll-deficient mutants resulting from each treatment. Only "normal" plants, that looked like those from untreated seed, were selected for combining-ability studies. General and specific combining ability was estimated from the forage yields of 3×3 Design II (factorial design) crosses between two sets of three plants of the same treatment from each of two parent inbreds. Results in 1968 indicated that mutagen treatment did not significantly alter either average forage yields or average forage yield variances of 162 singlecrosses in 18 Design II sets. The combining ability results from 27 complete Design II sets and a number of incomplete sets have been inconsistent, but suggest that the mutagenic agents may have increased the per cent of non-additive genetic variance (specific combining ability). (auth)

41834 COMBINING ABILITY OF WINTER WHEAT. Ramirez A., I.; Allan, R. E.; Konzak, C. F.; Becker, W. A. (Washington State Univ., Pullman). pp 445-55 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

A combining ability analysis was performed for plant height components, grain yield and yield components with the F_1 generation of a diallele cross among isogenic lines of the backcross Norin 10/Brevor-14//6 Burt and gamma-ray induced mutants of the variety Burt (CI 12696). Parents representing very short, semi-short and standard adult plant height phenotypes were selected for the crosses. The isogenic lines chosen and their mean plant stature were: WA5490 (34 cm), WA5492 (59 cm), and WA5493 (87 cm). The mutant parents included M937, WA4563 (52 cm); M818, WA4564 (62 cm); and M1789, WA5489 (85 cm). Highly significant mean square (MS) values were determined in the combining ability analysis of variance (ANOV) for plant height components, yield and yield components for both general combining ability (GCA) and specific combining ability (SCA), with the exception of SCA MS for spike length and internode IV length. For plant height, yield and yield components, the major part of the total genetic variance observed was due to GCA effects. High values for GCA/SCA ratios were noted in plant height components, and smaller ones for yield and yield components. Significant negative GCA effects were associated with the short and semi-short isogenic parents for all plant height components while the tall isogenic line and the mutant parents had positive GCA effects. For yield and yield components, significant and uniformly negative GCA effects were associated with the three isogenic line parents but were positive for the mutant parents. Positive and negative significant SCA effects were observed for components of plant height, yield and yield components in several of the hybrid combinations tested. Data indicated that the short and semi-short isogenic lines were more effective than the mutant parents in maintaining a short-strawed phenotype in the F_1 generation. The mutant parents, on the other hand, were more effective for transmitting better grain yield characteristics to the F_1 hybrids. The relative magnitude of the GCA/SCA ratios showed that the additive type of gene action is more important than the dominance type in the expression of yield and plant height. Additive genetic variance and additive × additive type of interactions seem to prevail over dominance and epistatic variances within the material studied in the control of plant height components, as well as for yield and its components. The GCA/SCA ratios indicated that additive genetic variance was more important in plant height expression than in yield characteristics. In the latter, dominance

variance had a greater share of the total genetic variance. The results demonstrated that the mutant lines when used as parents contribute genotypic additive and dominance variance of the same kind as those found in natural variability sources for both plant height and yield characters. Significant SCA effects suggested that superior yielding hybrid combinations might be obtained in crosses of isogenic lines and mutant germ plasm of the type used in this study. In this sense, it is thought that "combination breeding" by crossing natural with artificially induced variability sources holds definite promise as an additional efficient tool for conventional plant breeding. (auth)

41835 GENETIC VARIATION IN IRRADIATED AND CONTROL POPULATIONS OF CORN AFTER TEN CYCLES OF MASS SELECTION FOR HIGH GRAIN YIELD. Gardner, C. O. (Univ. of Nebraska, Lincoln). pp 469-77 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969). (COO-1512-16).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

A mutation breeding program to improve grain yield of corn (Zea mays L.) was initiated in Nebraska in 1955. The idea was to induce new genetic variation by irradiating seeds with thermal neutrons, eliminate inferior genotypes and those with serious chromosomal abnormalities by selecting the phenotypically highest yielding plants, and to recombine the most favourable genes in the population each generation by random mating among offspring of plants selected in the previous generation. One seed sample from the open-pollinated variety Hays Golden received thermal neutron treatment initially and again at generation 2. An untreated sample provided the control. Both populations are grown in isolation each year and the highest-yielding plants (10%) provide seed for the next generation. Special selection techniques are used. Response to selection has been linear in the control with a gain of 2.7% per generation. No progress was made in the irradiated sample until treatment was discontinued. From generation 3 on, a rapid linear response of 4% per generation was realized. In generation 10, full-sib families nested within half-sib families (Design I mating system) were produced and were tested in 1967 and 1968 to evaluate genetic variation and predict future progress. Results indicate that thermal neutron treatment increased prolificacy and thus increased additive genetic variance for both prolificacy and grain yield. Selection in both populations resulted in higher grain yield, greater prolificacy, taller plants and later maturity. At generation 10, selected control and irradiated population means are equal, but greater future gains and a higher selection limit are predicted for the irradiated population. (auth)

41836 MUTATIONS INDUCED BY TREATING MAIZE SEEDS WITH THERMAL NEUTRONS. Singleton, W. R. (University of Virginia, Charlotteville). pp 479-83 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

In 1967 seed of the B14 maize inbred was treated with thermal neutrons at the Brookhaven National Laboratory and then planted in an isolated field at the National Colonial Farm, and allowed to interpollinate. Seed harvested from this field was planted in 1968, and more than 1000 self-pollinations were made. Samples of seed from each ear were planted in seedling benches and observed for mutations. Of 1074 progenies tested, 52 or 4.8% were segregating for some seedling character, mostly in good monogenic ratios. Most segregations were for albino seedling, but a few were for such characters as luteus, yellow-green, virescent, and dwarf. The method described is efficient for recovering viable mutants, 52 from 1074 progenies tested. This method should be applicable to other cross-pollinated crops. It is being tried with American chestnuts, Castanea dentata, in an attempt to induce a mutant resistant to the chestnut blight, Endothia parasitica. (auth)

41837 PROBLEMS IN USING EXPERIMENTAL MUTAGENESIS FOR BREEDING PURPOSES. Scarascia-Mugnozza, G. T. (CNEN, Rome). pp 485-99 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

A comprehensive review is given, covering comparison of physical mutagens, dose levels and frequency of positive mutations, studies on the size of the chimeric sector, induced variation in quantitative characters, chromosome and genomatic mutations, chronic, recurrent and combined mutagenic action, mutagen specificity and mutability at specific loci, and a wide range of other factors. (auth)

41838 STUDY OF THE DESCENDANTS OF A SEX MUTANT IN ECBALLIUM ELATERIUM RICH. Gomez-Campo, C.; Casas-bullia, M. (Instituto Nacional de Investigaciones Agronomicas, Madrid). pp 501-7 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969). (In Spanish).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

With thermal neutrons and gamma rays as mutagenic agents, as many as four sex reversions from male to female were brought about in plants of the dioecious variety of Ecballium elaterium. In all these changes, which appeared to be basically similar, it was noted that the racemose arrangement of the flowers natural to male plants remained unaltered. Two of the plants produced enough seed for a study of their descendants. The phenotypic proportions of M_2 and M_3 can be related to 2 : 1 : 1 and 4 : 1 : 3, respectively. It was further confirmed that some of the male plants from both generations are capable of transmitting this characteristic when crossed with normal female plants. The results suggest that sex changes obtained correspond in effect to mutations in the dominant factor (a^D), which determines the male sex of this variety, and that development of the floral raceme depends on another dominant factor (rac^+), closely linked to the former although different from it. Through the mutation induced in the former the existence of the latter has been shown; this might have passed unnoticed except in the rather unlikely case of a spontaneous mutation or natural crossing over. The resulting racemose female plants are clearly different from the normal ones, which have only one flower on each axil. By directed crosses it was possible to produce homozygotic genotypes (rac^+/rac^+) for both sexes and thereby make the new strain pure. Its development and physiological behaviour appear completely normal, but in relation to the original material there is the obvious ecological disadvantage of a reduced efficiency in seed dispersal. (auth)

41839 SOME USEFUL MUTATIONS INDUCED BY GAMMA IRRADIATION IN RICE. Tanaka, S. (Inst. of Radiation Breeding, Ohmiya, Japan). pp 517-27 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

From about 1400 mutants induced by gamma irradiation in growing plants, some mutants were selected for use in rice improvement. These mutants possessed characters such as early maturity, blast resistance and high protein content. While the mutant lines with early maturity mature earlier than their mother variety by more than one month, some of them are as productive as, or even more productive than, their mother variety under increased plant density. Most of those selected had shorter culms and higher lodging resistance. Although the mutation rate was very low, a dominant mutation promoting resistance to blast was induced. Of the mutants with a change in protein content, some have a doubled protein content and some a reduced protein content in comparison with that of the mother variety. In about 200 mutants with changes in maturity, no significant correlation was found between the growing time and the protein content. Since useful mutations can be induced in both visible characters and chemical components of rice, it is concluded that the use of mutations for rice improvement is extremely effective. (auth)

41840 SOME PROBLEMS OF PHYSIOLOGICAL MUTANTS IN WHEATS. Starzycki, S.; Sowa, W. (Plant Breeding and Acclimatization Inst., Warsaw). pp 529-33 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

The best results in wheat breeding are obtained from breeding short-straw and dwarf wheats. The yield of the intensive European winter wheat varieties tested in the experiments in Poland fluctuates between 40 to 70 q/ha of grain. These varieties effectively use nitrogenic fertilization at the rate of 80 to 90 kg/ha. Research at the Plant Breeding and Acclimatization Institute on breeding winter wheat mutants includes the definition of some physiological aspects of wheat intensiveness. There is a close relationship between the ripening period in particular varieties and their production abilities. The length of the ripening period expressed in days from flowering to maturity is given for varieties with different degrees of intensiveness. The length of the ripening period is genetically related to the ability to develop a definite number of ears per unit area. Through the use of mutations it is possible to obtain lines exceeding the most intensive varieties. (auth)

41841 SELECTION FOR RESISTANCE TO SPROUTING IN ^{60}Co-IRRADIATED WHEAT. Kivi, E. I.; Ramm-Schmidt, C.

(Plant Breeding Inst., Hankkija, Finland). pp 535-40 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

A Finnish spring wheat variety, Ruso (released in 1967), was irradiated with 15,000 and 20,000 rad from the ^{60}Co source at the Institute of Radiochemistry of the University of Helsinki. The M_1 and M_2 generations were grown in a plastic greenhouse. The M_3 generation grew in the field in 1968 and totalled approximately 5,000 progenies, each originating from one M_2 plant. During the season all deviating and segregating progenies were investigated. From all M_3 pedigrees without any morphological or visible physiological mutations a sample of 5 ears was taken approximately 5 days after yellow ripening and placed into a moist chamber with about 100% air humidity. When each sample achieved the stage of sprouting determined beforehand, it was taken out of the chamber. The 24 slowest sprouting progenies and, for genetic studies, some of the fastest sprouting ones, were harvested from the field. Among the slowest sprouting progenies there are 5 cases in which 2 to 4 pedigrees originated from one M_1 plant. During the winter the descendants of these pedigrees were grown under glass for testing the genetic significance of the observed variation of sprouting resistance in spring 1969. (auth)

41842 IMPROVEMENT OF LOW YIELDING SWEET CLOVER MUTANTS BY HETEROSIS BREEDING. Micke, A. (International Atomic Energy Agency, Vienna). pp 541-50 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Mutants of sweet clover (Melilotus albus), selected for a particular desirable character (low content of the glucoside of orthooxycinnamic acid) but inferior to the wild strain in green-matter production, can be restored in viability and increased in yield over the wild type by crossing with other mutants of the same category. This has been shown previously and has been confirmed by a second trial under different environmental conditions. By extensive qualitative and quantitative chemical analyses it became evident that the observed heterosis effect is not correlated with the amount of glucoside within the plant tissue. Therefore, it is assumed as a working hypothesis that the relatively high doses of x rays and thermal neutrons produce so many other changes in the genetical background of the low glucoside mutants that heterosis is likely to occur by hybridization and even by a backcross to the wild strain. This assumption gets support from morphological differences among the mutants of the same low glucoside category. Different yield components were checked for their relative contribution to the hybrid yield and 14 low glucoside strains were tested with regard to their suitability as components for a synthetic variety. These results may serve as a model for the use of induced mutations in plant breeding, particularly in crops where heterosis breeding is feasible and the purpose of cultivation is not the harvest of fruits or seeds, but rather the total yield in vegetable matter. (auth)

41843 PROGRESSIVE MUTATIONS IN LEGUMINOSAE. Gottschalk, W. (Univ., Bonn). pp 559-72 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

A survey is presented on the selection value of 226 fertile mutants of Pisum sativum. Some mutants are characterized by developing a leaf structure not known elsewhere in the family. Extremely divergent leaves could be obtained by combining specific mutant genes which show both an additive and a cumulative action. Corresponding results were obtained with two mutants showing interesting evolutionary alterations of their flower structure. The mutations studied are interpreted as being progressive ones; they are compared with similar mutations in different genera of the family having different selection values. (auth)

41844 CHARACTERISTICS AND INHERITANCE OF RADIATION-INDUCED MUTATIONS IN BARLEY: SOME EXTREME MUTATIONS. Tsuchiya, T. (Colorado State Univ., Fort Collins). pp 573-90 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Characteristics and inheritance of five types of radiation-induced extreme mutations are briefly reported: Female or multi-ovary (Kmut 184a) induced by x-ray treatment completely lacks anthers which have changed to pistils (pistillody); culms thick; leaves coarse and dark green; awns coarse; completely sterile even when it was pollinated by normal pollen. Simple Mendelian recessive; gene symbol mo2 was assigned. Male or ovaryless (Kmut 21b) induced by gamma-ray treatment had vestigial ovary and three well developed anthers; leaves completely lacking midrib, droop at the leave base; spikes lacking awns are characteristic of this mutant; lemma is slightly shorter than palea, indicating inferior development of the former. Simple recessive mutation; gene symbol ovl was adopted. Leafless or deficient lamina (Kmut 255) is an incompletely dominant mutation. Homozygous mutants completely lack the normal leaf blades on most of the culms with a plant height of about 10 cm; under 24-hour days with supplemental illumination provided by tungsten light, some homozygotes produce one culm which is shorter than heterozygotes and has smaller spike and short awn. The heterozygotes grow vigorously with nearly normal fertility (90.5% on an average). Heterozygous mutants had peculiar auricle-like appendages on the leaf margin, thereby distinguishing them from normal plants. Gene symbol Lfl was adopted. Minute or extreme dwarf (Kmut 63) is a simple Mendelian recessive mutation with very short, dark-green, wavy leaves and many tillers which usually die without developing culms. With a spray of diluted gibberellin solution (100 ppm) these plants started to grow normally, producing normal sized spikes with good fertility. Gene symbol min 3 was given. Minute or extreme dwarf (Kmut 246) is another minute with characteristics very similar to those of the minute mentioned above (Kmut 63). This mutation is controlled by a simple Mendelian recessive gene. A gene symbol was not adopted. The homozygous mutants have never produced culms under ordinary field conditions, whereas some tillers shot culms when grown under 24-hour day length in the greenhouse in Colorado. This abnormal behaviour, similar to that of the homozygous plant for leafless (Lfl), is tentatively ascribed to the long day treatment, although critical study is needed to verify this assumption. (auth)

41845 INDUCED SOMATIC MUTATIONS FOR INTERPRETING FLORAL DEVELOPMENT AND INFLORESCENCE AGING. Mericle, L. W.; Mericle, Rae P. (Michigan State Univ., East Lansing). pp 591-601 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Somatic mutations induced by acute ionizing radiation can be valuable tools in developmental biology by serving as ontogenetic time-clocks. Results of studies on mutations at the delphinidin locus in clone 02 Tradescantia are presented. Loss, inactivation, or mutation of this locus, mediated by any of several mechanisms, results in the production of purplish-red "mutant" cells within otherwise normally purplish-blue petals and stamen hairs. The studies herein reported encompass a number of different mutation parameters. Among these, mutation responses of both petals and stamen hairs are examined in terms of their time of occurrence (post-radiation), magnitude and duration. In addition, the mutant patterns manifest at anthesis are themselves analyzed as to changes in sector type, sector size, and spatial distribution within the particular organ during the response period. The mutation response curves and times at which changes in sector pattern occur undergo alterations as an inflorescence becomes older. These data correlate well with our previously reported studies of flowering activity and cytological-morphological assessments of bud number, stages of floral ontogeny, and rate of transition from floral primordium to anthesis within inflorescences of different ages. From these combined data there now emerges a clearer picture of the changes in cellular activity which take place not only during the development of an individual flower, but also in aging of the inflorescence as a whole. A partial explanation is also provided for our earlier observation that spontaneous mutation rate becomes lower, and response to low-level chronic irradiation reduced in progressively older inflorescences of clone 02 Tradescantia. (auth)

41846 STUDY OF THE TETRASOMIC HEREDITY OF MUTATIONS INDUCED IN ARABIDOPSIS THALIANA. Bouharmont, J. (Univ. Catholique, Louvain, Belg.). pp 603-10 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969). (In French).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Tetrasomic heredity has been the subject of various publications on the theoretical distribution of different genotypes and phenotypes over a number of generations, in order to determine the segregation of chromosomes and chromatids. However, precise experimental verification has been rare due to the number of

generations and the number of progeny which have to be studied. These studies are of considerable interest since many cultivated plants are polyploid. Arabidopsis thaliana, a species frequently used in genetic work, is particularly suitable for studies of tetraploids because it is possible to observe lethal chlorophyll mutations at the embryonic stage in the plants of the preceding generation. Lethal chlorophyll mutations were induced by x rays and by means of 1-methyl-3-nitro-1-nitrosoguanidine. Diploid and tetraploid plants of the Arabidopsis species were treated in this way. In the tetraploid line, no mutants appeared in the second generation. In the third generation, some of the progeny, corresponding to duplex plants which had themselves been derived from sectors mutated in the first generation, exhibited white embryos (completely homozygous for the mutation). The progeny of these duplexes comprise duplexes and simplexes which exhibit ratios of mutated to normal embryos of approximately 1:35 and 1:3 respectively. Other duplex plants were produced by doubling the chromosome number in heterozygotes obtained by mutagenic treatment at the diploid level. The observed ratios correspond to chromosome segregation. Close study of a particular mutation shows that this locus is near the centromer. Segregations of this character in diploid plants and in duplex tetraploids do not show any deviation due to a reduction in fertility. On the contrary, the frequency of recessive alleles is reduced in the progeny of the simplexes. (auth)

41847 EXPERIMENTAL INDUCTION OF HAPLOID PARTHENOGENESIS IN FOREST TREES. Stettler, R. F.; Bawa, K. S.; Livingston, G. K. (Univ. of Washington, Seattle). pp 611-19 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Several uses for haploids in forest-genetics research are discussed. In 1964, we began systematic studies on the experimental induction of haploid parthenogenesis in black cottonwood (Populus trichocarpa T. & G. ex Hook.). Nine trees from nine geographically separate natural populations in the state of Washington served as female parents. They were treated with irradiated pollen (20, 40, 80, 100 kR) alone in combination with pollen from any of five different species of the genus Populus. Intensive cytological examinations were performed on immature embryos and on seedlings. Haploids were found at low frequencies both among embryos and seedlings. In addition, maternal-species phenotypes were found with diploid chromosome numbers resulting either from contamination or from spontaneous chromosome doubling of haploids. The most responsive female produced haploids in three successive years at frequencies of practical significance. Another study, with Douglas-fir, (Pseudotsuga menziesii (Mirb.) Franco), involved screening for individuals with a good selfing performance. Several good selfers were found, some carrying genetic markers. In 1968, their female strobili were exposed to various treatments, including irradiated pollen (4, 8, 16, 32 kR), and growth substances (indole butyric acid, gibberellic acid, naphthaleneacetic acid) administered at the time of receptivity. Filled seeds were obtained from GA and IBA treatments, as well as from irradiated pollen, but less so from high doses than from low doses. Germination and cytological examination of germinants are in progress. (auth)

41848 X-IRRADIATION-INDUCED S-GENE MUTATIONS, ACCUMULATED CENTRIC CHROMOSOME FRAGMENTS, AND EVOLUTION OF B-CHROMOSOMES. Pandey, K. K. (Dept. of Scientific and Industrial Research, Palmerston North N. Z.). pp 621-35 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Studies of the x-ray-induced mutations of the S complex, which controls intra- and interspecific pollen-style incompatibility, have thrown considerable light on the evolution of genetic mechanisms governing the breeding behavior of flowering plants. Six species, Oenothera organensis, Prunus avium, Trifolium repens, T. pratense, Petunia inflata, and Nicotiana alata, have so far been studied for the S-gene mutation. In only two of these, P. inflata and N. alata, the mutations are usually associated with the presence in the nucleus of an S-gene duplication, usually borne by a free centric chromosome fragment. The fragment may vary in size from a very tiny segment to a size indistinguishable from the normal S-bearing chromosome. In the present investigation, new x-irradiation-induced mutants in N. alata were examined with special reference to the associated extra chromosome fragments. The number of fragments was determined up to four generations following irradiation. With the successive generations there was an increase in the number of fragments in a few plants but, generally, the number of fragments tended to remain low. Plants having different numbers of fragments were studied, genetically and cytologically, by examination of their meiotic division, pollen fertility, seed-set per capsule in selfs and crosses, and germinability of seeds. These observations are discussed in the context of: the possible role of the spontaneous S-chromosome fragments in the evolution of new, increased, haploid chromosome numbers of species; and the evolution of supernumerary (B) chromosomes, found in many genetic cultures and varieties of certain species. (auth)

41849 NATURE OF CHROMATID DELETIONS. Heddle, J. A.; Bodycote, D. J.; Whissell, D. (Univ. of California, San Francisco). pp 637-43 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

There are two general hypotheses that provide a formal understanding of the production of chromosomal aberrations. They differ primarily in the way in which they account for chromatid deletions. According to the breakage-first hypothesis of chromosomal aberration formation, chromatid deletions that are apparently simple disruptions of chromatid continuity are unrepaired simple breaks. On the other hand, the exchange hypothesis proposes that each chromatid deletion is the result of a failure to complete an exchange between two segments of a chromosome at a place where it is thrown into a loop. To distinguish between these two hypotheses, we have examined chromatid deletions in cells that were first pulse-labeled with tritiated thymidine and later x-rayed just before the second mitosis after labeling. At the time of the second mitosis, each chromosome has one chromatid labeled and the other unlabeled so that exchanges between the chromatids are easily detectable autoradiographically. The examination has revealed that many of the terminal deletions are indeed incomplete exchanges. The proportion is not, however, in accord with the idea that all chromatid deletions arise at the point of overlap of a chromosomal loop. Chromatid deletions are, therefore, a mixture of one-hit deletions and incomplete exchanges between sister chromatids. We have been unable to distinguish between these two types of deletions morphologically. (auth)

41850 USE OF CHROMOSOME ABERRATIONS IN PRODUCING FEMALE PARENTS OF HYBRIDS. Ramage, R. T. (Agricultural Research Service, Tucson, Ariz. Univ. of Arizona, Tucson); Wiebe, G. A. pp 655-9 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

The first commercial hybrid barley has been released by the US Department of Agriculture and the University of Arizona. The female parent of this hybrid is a genetic recessive male sterile diploid that is propagated by a balanced tertiary trisomic. The balanced tertiary trisomic consists of a normal diploid complement of chromosomes plus an extra translocated chromosome. The extra chromosome is the 2^T chromosome from the x-ray-induced translocation T2-7d. The development of hybrid barley has led to the contrivance of a means of using chromosome aberrations to produce populations of genetic recessive male sterile diploids. Such populations will serve as female parents of hybrids. The system uses three components: an extra chromosome, a genetic recessive male sterile gene, and informational genes. The extra chromosome must be incapable of independent transmission; it must be accompanied in its inheritance by one of the normal chromosomes of the diploid complement. Further, it must not be transmitted through the pollen but through the eggs. In most diploid species translocated chromosomes should serve as the extra chromosome. In allopolyploid species, various telocentrics, isochromosomes and centric chromosome fragments exist, or can be produced, that should serve as extra chromosomes. The locus of the male sterile gene must be on the extra chromosome. Genetic recessive male sterile genes are of common occurrence in many species. It should be possible to find one located on any particular extra chromosome. Informational genes are those that aid in identification and separation of diploids from individuals carrying the extra chromosome. They may involve many characters such as color of plant or seed, plant shape or height, or seed shape or size. The loci of informational genes must also be on the extra chromosome. This scheme of producing populations of genetic recessive male sterile diploids is capable of adaptation to a number of species. (auth)

41851 ANEUPLOIDY INDUCED IN TETRAPLOID WHEATS BY MEANS OF MUTAGENIC TREATMENTS. Bozzini, A. (CNEN, Rome); Giorgi, B.; Martini, G. pp 661-9 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of

Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Direct production of aneuploidy is possible by means of gamma-ray treatment of plants during gametogenesis. Experiments were performed on T. durum cv. Cappelli, T. dicoccoides, T. timopheevi and the amphiploid (Aegilops caudata × T. thaudar, 2n = 28). With this method nearly all the aberrant individuals found were aneuploids with a deficiency of all or some of the chromosomes, while only in a few cases were polysomic plants found. Aneuploids can be accumulated by analyzing the slow germinating seeds from the treatment. The percentage of aneuploids induced seems to be in relation to the degree of diploidization of the line used. The artificial amphiploid (Ae. caudata × T. thaudar) showed, in fact, the highest percentage. Another source of aneuploids in durum wheat was provided by the routine cytogenetical analyses of mutant lines obtained by treatment of seeds with chemical and physical agents. Trisomics, tetrasomics and, in general, polysomics were isolated, particularly in progenies showing reciprocal translocations or meiotic disturbances (mostly desynapsis). About 50 trisomic lines were actually investigated and backcrossed to the same variety, Cappelli, in order to eliminate structural aberrations and other mutations present in the material derived from the treatment. Cytogenetical and morphological analysis performed on this material demonstrated: good transmission of trisomy (about 30%); good viability and fertility of polysomics (data from material ranging from 2n = 29 up to 2n = 61); the possibility, in some instances, of identifying the trisomics by morphological or biometrical analysis. In conclusion, this research shows the suitability of mutagenic treatments for the production of aneuploids, together with the possibility of obtaining both monosomics and trisomics, by modification of the technique used. (auth)

41852 PROGRESS IN MUTATION BREEDING. Sigurbjoernsson, B.; Micke, A. (International Atomic Energy Agency, Vienna). pp 673-98 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

The history of mutation breeding was marked initially by enthusiasm and considerable activity without a commensurate yield of improved varieties. This was a period of intensive study of the mutation process and of ways of harnessing mutation induction for practical purposes in plant breeding. Interest and activity then tapered off until recently, when a number of significantly improved crop varieties bred by induced mutations started to appear on the market and gain acceptance by farmers. The last few years have been marked by an upswing in activity, great improvement in methodology and increased interest in mutation breeding as an essential and unique complementary method of breeding. The paper illustrates, with examples, the progress made and where induced mutations have made their greatest practical impact. A complete list of released crop varieties derived from induction of mutations is presented. (auth)

41853 ADAPTATION STUDIES WITH RADIATION-INDUCED DURUM WHEAT MUTANTS. Bogyo, T. P. (Washington State Univ., Pullman); Scarascia-Mugnozza, G. T.; Sigurbjoernsson, B.; Bagnara, D. pp 699-717 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Research on durum wheat radiation genetics was started in Italy in 1956 by G. T. Scarascia-Mugnozza and collaborators, and several promising lines have been obtained. In 1965, during the eighth FAO/NE Technical Meeting on Wheat and Barley Improvement, held in Teheran, Iran, it was decided to start uniform trials on these durum wheat mutants under the joint auspices of the Food and Agriculture Organization of the United Nations, the International Atomic Energy Agency and the Italian Nuclear Energy Committee. The trials have been conducted over four years (1965 to 1969) at up to 28 different locations, and much important information has been collected. The data for the first three years have now been jointly analyzed and detailed information provided in a report by Bogyo, Scarascia-Mugnozza, Siburbjörnsson and Bagnara (1969). The results showed that many of the mutant lines not only yielded more than the local varieties and the common varieties in the trials, but had greatly improved characters, such as shorter straw, better resistance to lodging, shorter period to maturity coupled with longer period of ripening and better volume weight of grain. Some limited success was found with regard to reduced incidence of yellow berries, although new measuring techniques will be necessary for better determination of this character. Three of the mutant lines in the trials have already been commercially released as improved varieties. A study of genotype-environment interaction for many of the measured characteristics also has been carried out. For several of these there is an almost complete lack of this interaction, indicating an unusually good general adaptation to a very wide geographical area. For others there is an indication of a high location × year × variety interaction, indicating that one should classify each experiment as an individual environment rather than thinking in terms of yearly variations of a given location. It is interesting to note that most of the characteristics which show this tendency, such as periods to heading and to maturity, are related to the physiology of the plant. Consequently, a linear regression model is suggested to identify some of the environmental factors associated with genotype-environment interaction in durum wheat. It is suggested that better information on environmental conditions be obtained for future experiments. These should include temperature, moisture availability, insect and disease conditions, fertility level and average productivity of the soil type. These environmental data would provide a better insight into the physiology of durum wheat in addition to giving information on the relative importance of these factors and thus be of future aid in selecting newer and better lines. (auth)

41854 ROLE OF MUTATION BREEDING IN A CHANGING AGRICULTURE. Swaminathan, M. S. (Indian Agricultural Research Inst., New Delhi). pp 719-34 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

A summary is presented of research on mutations induced by radiation and chemical mutagens with emphasis on breeding of crop plants in India. Some topics discussed are development of a drought escaping strain of castor and the introduction of double cropping in single-crop areas; repatterning the ear architecture of bread wheat for better productivity under unirrigated conditions; mutational rectification of defects in well-adapted genotypes; mutations for quality characters in rice; improving the branching potential of autotetraploid Brassica campestris; enhancement of the frequency and spectrum of induced mutations; and mutation breeding as a tool for breaking new trails in agriculture. (H.L.W.)

41855 GENETIC FUNCTION CORRELATED WITH UNFOLDING OF LAMPBRUSH LOOPS BY THE Y CHROMOSOME IN SPERMATOCYTES OF DROSOPHILA HYDEI. Hess, Oswald (Univ., Freiburg i. B.). Mol. Gen. Genet.; 106: 328-46(1970).

Deficiencies of the Y chromosome of Drosophila hydei including sites which develop lampbrush loops invariably cause sterility of males. Suppression of loop unfolding in one or more sites equally results in similar morphogenetic defects of spermiogenesis. A variegated type repression of lampbrush loop unfolding observed during the spermatocyte stage results in varying morphogenetic effects on spermiogenesis. This demonstrates the existence of causal relationships between the active phase of Y chromosomal factors in spermatocytes and the differentiation processes in spermatids. In some translocated Y fragments the mode of unfolding of a particular pair of lampbrush loops may be permanently changed. As a result, lampbrush loops of a mutant phenotype are developed. Some alterations of this type are correlated with functional alterations resulting in defective spermiogenesis. Three different fragments of the Y chromosome in which lampbrush loop formation was repressed have been tested for possible reversions of loop suppression by means of x irradiations. In none of the three cases has reversion been detected among two thousand tested chromosomes. (auth)

41856 NONSENSE MUTANTS OF SERRATIA PHAGE KAPPA. I. THEIR ISOLATION AND USE FOR PROVING CIRCULAR LINKAGE OF THE PHAGE GENES. Winkler, U.; Kopp-Scholz, U.; Haux, Ch. (Ruhr Univ., Bochum, Ger.). Mol. Gen. Genet.; 106: 239-53(1970).

Auxotrophs of Serratia marcescens HY, which behaved like nonsense mutants when tested according to Whitfield et al. (1966), were induced to revert to anauxotrophy. Some of the revertants (called su^+), together with the parental auxotrophs (called su^-), allowed to isolate conditional-lethal (sus) mutants of phage Kappa, which produce infectious progeny only in su^+ bacteria. All su^+ mutants of Serr. marcescens HY were identified as nonsense suppressors using su^+_{amber}, su^+_{ochre}, and su^- strains of Salm. typhimurium as references and the flagella-specific phage Chi as the main tool to connect the Salmonella system with that of Serratia. After treatment of Kappa with three different mutagens 128 sus mutants were isolated that comprise at least 19 complementation groups. Eighteen sus mutants, representing different cistrons, and the unselective markers c1, c2, and e49 were mapped mainly by two-factor crosses. Reciprocal three-factor crosses of the general type a × bz and az × b (i.e. with outside markers) re-

vealed a circular linkage map of an estimated maximum length of 90 RU (recombination units). Joined rescue of outside markers, e.g. sus+ A94 and e49, from uv-irradiated phage supported the assumption of circular gene linkage. Some data indicate that certain regions of the phage genome might have a higher chance to recombine than others. (auth)

41857 ON THE BIOLOGICAL EFFECTS OF HIGH BACKGROUND RADIOACTIVITY: STUDIES ON TRADESCANTIA GROWN IN RADIOACTIVE MONAZITE SAND. Nayar, G. G.; George, K. P.; Gopal-Ayengar, A. R. (Bhabha Atomic Research Centre, Trombay, India). Radiat. Bot.; 10: 287-92(Jun 1970).

Tradescantia, clone 02, plants were grown in garden soil and were exposed to low level external radiations ranging from 0.08 mR/hr to 1.3 mR/hr or were raised in radioactive monazite sand cultures. In the experiment on external exposure alone, one group of plants was irradiated from transplanting while another group was irradiated from flowering. The occurrence of somatic mutations in the staminal hairs was recorded from flowering, for a period of over sixty days. After the specified period of growth, the plants from the monazite cultures and control were sacrificed and assayed for the absorbed radionuclides, especially for the alpha emitters. The radionuclide content in the plant body did not show a direct relation with the amount of monazite in the cultures. It appears that the contribution from the absorbed radionuclides is much more important in the production of biological damage than external irradiation alone. (auth) (UK)

41858 MUTANTS OF ESCHERICHIA COLI DEFECTIVE IN THE B PROTEIN OF TRYPTOPHAN SYNTHETASE. III. INTRAGENIC CLUSTERING. Crawford, I. P.; Sikes, S.; Belser, N. O.; Martinez, L. (Scripps Clinic and Research Foundation, La Jolla, Calif.). Genetics; 65: 201-11(Jun 1970).

A large collection of mutants in the trpB gene of Escherichia coli was positioned into 21 linearly ordered areas by recombination tests with deletions. The proximal third of the gene contains nonsense and repairable missense types, but few conventional CRM-forming mutants. The middle third of the gene has chiefly nonsense types, with one hot spot for NG mutagenesis yielding an ochre phenotype. The distal third contains mutations of all types, with significant clusters of both repairable and CRM-less mutants. A rather large group of unclassified nonsense mutants scatters throughout the gene. Several possible explanations are proposed for this group. (auth)

41859 BEAN MUTANT INDUCED BY IONIZING RADIATION. IV. PEPPER MUTANT. Moh, Carl C.; Nanne, Henry (Inter-American Inst. of Agricultural Sciences, Turrialba, Costa Rica). Contract AT(30-1)-2043. Turrialba; 19: 292-3(Apr-Jun 1969). (NYO-2043-199).

Seeds of Phaseolus vulgaris were pretreated at a temperature of 4°C, then irradiated with 2 kR of γ rays. A morphological mutant, called pepper, was isolated in the self-progeny test. The mutant plants are completely sterile. It was shown that the pepper mutant is a recessive character and is controlled by a single gene. (F.M.M.)

41860 VARIATIONS IN THE RADIOSENSITIVITY OF OOCYTE CHROMOSOMES DURING MEIOSIS IN DROSOPHILA MELANOGASTER. Koch, Elizabeth A. (Chicago Medical School); Smith, Patricia A.; King, Robert C. Chromosoma; 30: No. 1, 98-108 (1970).

The synaptic stages of meiosis in Drosophila melanogaster females are very resistant to the induction of dominant lethal mutations by ionizing radiation. It is assumed that dominant lethals result from interstitial chromatid deletions, and that almost all potential chromatid breaks are repaired in synaptic cells. The type of dose response curve shown by oocytes at later developmental stages is a function of the degree of chromatid coiling and the presence or absence of an investing nuclear envelope. (auth)

Health Physics and Safety

Refer also to abstracts 41642, 41888, 41906, and 43682.

41861 ASSESSMENT OF HEALTH HAZARDS OF ELECTRON-BEAM METAL MELTING OR WELDING UNITS. Voitkova, N. I.; Sizikova, N. V.; Sobol, A. F. (Inst. of Hygiene and Industrial Diseases, Moscow). Ind. Med. Surg.; 38: 448-51(Dec 1969).

Possible dangers to workers in operation of electron-beam metal melting and welding are enumerated namely: toxic aerosols, high voltage, x rays, uv radiation, moving parts, ionized air, and others. Protective measures were devised against these hazards, and approved by appropriate authority. (auth)

Radioactive Contamination and Decontamination

Refer also to abstracts 41489, 41492, 41499, 41503, 41506, 41527, 41538, 41547, 41550, 41551, 41641, 41742, 41744, 41791, and 41795.

41862 (NP-18315) ENVIRONMENTAL RADIOACTIVITY IN NEW ZEALAND AND MEASUREMENTS ON SAMPLES FROM FIJI AND RAROTONGA. Quarterly Report, October-December 1969. (National Radiation Lab., Christchurch (New Zealand)). 11p. (NRL-F-37). Dep. CFSTI (U. S. Sales Only).

Results of routine monitoring of fallout in air, rain and milk samples during the fourth quarter 1969 are tabulated. These results are summarized on a quarterly basis and are presented graphically, together with results from previous quarterly reports during 1968 and 1969. As already noted in previous reports increased levels of fission products in air and rainwater were measured during the third quarter 1968. These levels resulted from the 1968 series of nuclear tests conducted by France in the Pacific Area between 8 July and 9 September. This series included for the first time the detonation of two hydrogen bombs. The expected decrease in levels, which had been evident during the months following the previous test series of 1966 and 1967, occurred more slowly following the 1968 nuclear tests. The greater delay in the reduction of fission product levels following the 1968 nuclear tests undoubtedly resulted from the injection of fission debris into higher altitudes when the hydrogen bombs were tested. The subsequent deposition of the debris was thus extended over a longer period. Since the first quarter 1969, however, there have been significant decreases in the levels of total beta activity of air filter and rainwater samples. The average levels in air and rainwater during the fourth quarter 1969 are compared with the average levels during the third quarter 1968 when peak levels occurred: The average levels in air during the fourth quarter 1969 were 0.10 pCi/m^3 at Auckland, 0.06 pCi/m^3 at Wellington and 0.05 pCi/m^3 at Christchurch. During the third quarter 1968 the levels were 0.23 pCi/m^3 at Auckland and Wellington, and 0.16 pCi/m^3 at Christchurch. Thus the levels have decreased to less than half of the peak levels measured during the 1968 nuclear tests. The total deposition in rain during the fourth quarter 1969 was 6.6 mCi/km^2 at Greymouth, and 2.6 mCi/km^2 at Christchurch. During the third quarter 1968 the deposition was 113 mCi/km^2 at Greymouth, and 16.4 mCi/km^2 at Christchurch. Thus the level at Greymouth has decreased to about 6%, and at Christchurch to about 16%, of the peak levels measured during the 1968 nuclear tests. Strontium-90 deposition changed little during the third and fourth quarters. The average deposition in rain during the fourth quarter 1969 was 0.29 mCi/km^2, and during the third quarter 1969 was 0.30 mCi/km^2. These levels are less than one quarter of the highest level previously recorded i.e., 1.33 mCi/km^2 during the first quarter 1965. The average deposition of ^{89}Sr in rain reached a maximum of 5.1 mCi/km^2 during October 1968, about one month after the conclusion of the 1968 nuclear tests. Levels have steadily decreased since then. During the fourth quarter 1969 levels had decreased to less than 0.1 mCi/km^2 per month. The average level of ^{90}Sr in milk has decreased from 7.9 Strontium Units during the third quarter 1969 to 5.8 Strontium Units during the fourth quarter 1969. The highest level previously recorded was 15.9 Strontium Units during July-August 1964. The average level for the twelve months ending December 1969 (6.7 Strontium Units) is about 2.5% of the permissible level for the whole population. The average level of ^{137}Cs in milk has increased slightly from 24 pCi/g K during the third quarter 1969 to 29 pCi/g K during the fourth quarter 1969. The average level for the twelve months ending December 1969 (28 pCi/g K) is 0.4% of the permissible level for the whole population. (auth)

41863 INFLUENCE OF SOIL pH ON THE FALLOUT ^{90}Sr CONTAMINATION OF SEVERAL CROPS IN SITU. Poelstra, P.; Frissel, M. J.; Reiniger, P. (EURATOM, Wageningen, Netherlands). pp 689-706 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

The influence of soil pH on the ^{90}Sr contamination of crops was investigated on an experimental field at three pH levels, 3.5, 4.2 and 5.0. Soil and crops were sampled once a year during a period of six years and analyzed for Ca and ^{90}Sr. On soil samples, taken from the top 20-cm layer, the exchangeable Ca and total ^{90}Sr content were determined. Crop samples were taken from the consumable parts just before harvesting and analyzed for total Ca and ^{90}Sr. Crops investigated include oats, rye, barley, wheat, peas, clover, ryegrass, potatoes and beets. A multidimensional calculation was set up to determine for each crop the yearly ^{90}Sr

contamination originating, respectively, from soil and from air. Total contamination was calculated as a function of soil pH, of ^{90}Sr amount in the soil, of ^{90}Sr deposition rate, and of additional soil and crop parameters. Calculations were made with an electronic computer. Results show clearly the influence of soil pH on ^{90}Sr contamination. In many cases it was twice as high at pH 3.5 than at pH 5.0. For many crops the direct foliar contamination (originating from the air) was up to 80% of the total contamination in 1963 and about 10% in 1967. (auth) (France)

41864 EXPERIMENTAL RADIOCONTAMINATION OF SEVERAL CULTIVATED SPECIES IRRIGATED BY SPRAYING. Delmas, J.; Disdier, R.; Grauby, A.; Bovard, P. (CEA-CEN, Cadarache, France). pp 707-29 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

The development of irrigation by spraying gives new importance to the aerial contamination process. Experiments were organized to simulate ^{90}Sr and ^{137}Cs contamination of the aerial organs of cultivated plants. The sprayings, carried out in a large conditioned sealed container, present certain essential characteristics of the method. The degree of contamination of the water was compared with that of the produce harvested. These results demonstrate the importance of this means of pollution of agricultural produce. (auth) (France)

41865 CONTRIBUTION TO THE EXPERIMENTAL STUDY OF THE DIRECT RADIOCONTAMINATION OF PLANTS. Lehr, J. (EURATOM-CEA, Fontenay-aux-Roses, France). pp 731-60 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

In order to study the mechanism of the direct contamination (by radioactive fallout or by contaminated irrigation water) of farm and market garden produce destined for human consumption, test models were designed using artificial water-borne contamination of several crops by radiostrontium and radiocesium. This research was based on the assumption that contamination may be due partly to a retention of polluted water intercepted by the crops, leading to a radioactive deposit on the plant after evaporation of the water, and partly to an absorption (or possibly adsorption) by the tissues of radioactivity from contaminated water flowing along the plant. The latter situation arises if the quantity of water falling per unit surface area exceeds the interception capacity. The two effects were studied in tests with single contaminations applied by spraying, the quantities of water, and on occasion its Sr and Cs activity also, being varied. Whereas in the case of interception the process is purely physical and mechanical, depending only on the activity of the water, contamination by absorption is more a biochemical effect in which the chemical composition of the water plays an important part. The effect of different cations (K,Ca) and anions (Cl^-, NO_3^-, SO_4^-, HCO_3^-) on the penetration of Sr and Cs was studied. (auth) (France)

41866 MECHANISMS OF CEREAL (WHEAT) CONTAMINATION EFFECTS ON THE POLLUTION OF FLOUR. Coulon, R. (CEA-CEN, Fontenay-aux-Roses, France). pp 833-62 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

A series of observations was made in 1964 and continued in 1965 on a variety of early winter wheat cultivated in the open field under standard conditions, its only source of radioactive contamination being the fallout due to earlier nuclear tests. The pollution observed on plots, where all or part of the plant was protected from the influence of direct fallout by plastic shelters set up during various stages of vegetation, is compared with that observed on a reference plot: it was possible to estimate the relative importance of these different stages, while the mechanisms were quantified by measurement of the radioactivity deposited during the corresponding periods. The measurements, carried out separately on the straw, the husk and the grain, involved ^{90}Sr, ^{137}Cs, ^{54}Mn, ^{106}Ru and ^{144}Ce and were supplemented by determinations of Ce, K and Sr. The fallout was estimated for these same radioelements by measurements on rainwater collected monthly. Complementary information on the distribution of the pollution inside the grain is obtained by measurements on the bran and flour fractions. From the results of these measurements carried out on average samples taken between 1963 and 1967, the distribution can be followed according to the relative contributions made by direct and indirect contamination. Finally, observation of the grain pollution of 10 different varieties of wheat cultivated under the same climate and soil conditions shows a clear influence of the variety factor. These results lead to certain practical conclusions: they allow a given contamination of the medium to be linked up with the resulting contamination of an important food vehicle such as wheat flour. (auth) (France)

41867 CONTAMINATION OF TERRESTRIAL GASTEROPODS LIVING IN A BIOLOGICAL MEDIUM WITH A LOW LEVEL OF ALPHA CONTAMINATION DUE TO PLUTONIUM AND URANIUM. Alvarez-Ramis, C.; Gregorides de los Santos, A. (Junta de Energia Nuclear, Madrid). pp 961-82 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

A study was made of the degree of contamination produced in the terrestrial gasteropods: Leucocroa candidissima Drap., Helix punctata Müll and Helix pisana Müll by damage to a thermonuclear bomb at Palomares (Almeria, Spain). The contamination of these animals is related to that of the plants on which they live, whether these are cultivated crops (maize, beans, tomatoes and cabbages) or wild plants native to the subtropical climate of the region (Lygeum spartum, Asparagus horidus and Passerina hirsuta). The degree of contamination of the different types of soil was also determined, the radioactivity being measured over the first five centimeters depth of the top layer where the animals are most easily and directly affected by the activity fixed. Finally the ratios between the soil and plant contamination and that of the flesh and shells of gasteropods were studied. (auth) (France)

41868 DATA. SECTION I. MILK AND FOOD. Radiol. Health Data Rep.; 11: 187-97(Apr 1970).

Data were collected by the Pasteurized Milk Network, sponsored by the Bureau of Radiological Health and the Bureau of Foods, Pesticides and Product Safety, Food and Drug Administration, U. S. Public Health Service. Methods of determining radioisotope content of milk, accuracy of data, and criteria used in setting up milk sampling activities are discussed. Radiation protection guides recommended by the Federal Radiation Council and related information pertaining to environmental levels during peace time and during a nuclear event are reviewed. A table is presented to show concentrations of ^{137}Cs, ^{131}I, and ^{90}Sr in milk during 1969 in various locations in the United States, Canada, Central and South America. Agencies concerned with food and diet surveillance are listed. (H.L.W.)

41869 DATA. SECTION II. WATER. Radiol. Health Data Rep.; 11: 198(Apr 1970).

Water sampling programs of the Public Health Service, the Federal Water Pollution Control Administration, and other federal, state, and local agencies are discussed. Standards recommended by the Federal Radiation Council for drinking water are 3 pCi/l for ^{226}Ra and 10 pCi/l for ^{90}Sr. (H.L.W.)

41870 DATA. SECTION IV. OTHER DATA. Radiol. Health Data Rep.; 11: 207-17(Apr 1970).

Semiannual reports on environmental levels of radioactivity in the vicinity of major AEC installations are reviewed. Summaries of data from the Lawrence Radiation Laboratory, the Neutron Devices Department, the Paducah Plant, and the Portsmouth Area Gaseous Diffusion Plant are presented. Data on atmospheric and water monitoring at the Berkeley Site (LRL) during January to June, 1969, are tabulated for α and β radioactivity. Data on $\beta-\gamma$ and fast neutron surveillance at the Berkeley Site during January, 1968, to June, 1969, are also tabulated. Concentrations of ^{7}Be, ^{144}Ce, ^{137}Cs, ^{3}H, ^{54}Mn, ^{106}Ru, ^{125}Sb, and ^{95}Zr in grass and eucalyptus leaves at the LRL Livermore Site are tabulated for January to June, 1969. Data on tritium concentration in sewer effluents, surface water, milk, and air at the Neutron Services Department of the General Electric Company, St. Petersburg, Florida, are reported for January to June, 1969. Results of the environmental monitoring program for January to June, 1969, at the Paducah Plant are presented in tables showing concentrations of uranium and β radioactivity in outdoor air and water samples and external γ radiation levels. Environmental surveys at the Portsmouth Area Gaseous Diffusion Plant during January to June, 1969, showed that natural uranium and ^{234}Th were the most likely radionuclides to be released. Tables are presented to show nuclear tests conducted at the Nevada Test Site during March, 1970. (H.L.W.)

41871 CONTRIBUTION TO THE RADIOMETRY OF CONTAMINATED WOUND AND BURN. Benes, Antonin; Fejfar, Bohumil. Sb. Ved. Pr. Lek. Fak. Karlovy Univ. Hradci Kralove; 12: 275-81(1969).

The role of direct radiometry in evaluation of radioactive surface contamination (skin, burn, wound) is discussed. A method is described to determine the degree of beta absorption by different kinds and various quantities of sanitary material used for the first-aid treatment and by the skin of different thicknesses. The measuring of radioactivity above the wound, dressing or splint from the exposure rate of gamma radiation in mR/hour is suggested. (auth)

41872 HYGIENIC EVALUATION IN CASES OF INHALATION OF RADIOACTIVE NUCLIDES MIXTURE IN FORM OF INSOLUBLE COMPOUNDS. Muller, J.; Malatoga, I.; Houskova, M.; Furgyik, S. Prac. Lek.; 21: 185-90(1969). (In Czech).

During a cyclotron run a maintenance worker became internally contaminated by inhalation of an unknown mixture of radionuclides. Components of the mixture were identified by radiochemical and γ spectrometric analysis. The retention function for the mixture of the insoluble compound of ^{182}Ta and ^{65}Zn was calculated from the whole body counter measurements covering 310 days. As this retention function is dependent on the effective cross section of inhaled particles and their solubility, generalization is not possible. It was possible, however, to apply it to a group of another 15 maintenance workers, who did similar work and were also contaminated. Thus the lung deposit could be calculated to the time of inhalation assuming that the mixture of radionuclides in the lung is distributed homogeneously. Since the internal contamination was found in the whole group of workers, it is obvious that the protection of the respiratory system used up to now, i.e., the method of a respirator with a filter, is not sufficient. (Excerpta Med.)

Dosimetry and Monitoring

Refer also to abstracts 41563, 41656, 41657, 41698, 41700, 41712, 41720, 41729, 41735, 41745, 41755, 42001, and 42004.

41873 (AECL–3430) BIOLOGY AND HEALTH PHYSICS DIVISION PROGRESS REPORT, APRIL 1–JUNE 30, 1969. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 44p. (PR-B–82). Dep. CFSTI (U. S. Sales Only). CAN $1.50.

Separate abstracts were prepared for the four sections in this report. The sections include a topical summary of the applications of dielectric track detectors to personal neutron dosimetry and abstracts of research being conducted in the Biology, Environmental, and Health Physics branches of AECL during the reporting period. (E.R.B.)

For abstracts of individual sections see: 41754, and 41874–41876.

41874 (AECL–3430, pp 1-3) NEUTRON DOSIMETRY AND DAMAGE TRACK DETECTORS. Marko, A. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.).

The application of particle track etching techniques to neutron dosimetry is discussed. Of particular interest, is a rapid method for determining whether an individual has received a neutron dose of biological significance. Particle track etching techniques in combination with the spark replica technique (discussed in the paper) seem to be useful for these rapid determinations. Other applications of the combined techniques are also discussed. (E.R.B.)

41875 (AECL–3430, pp 19-31) ENVIRONMENTAL RESEARCH. Mawson, C. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.).

Abstracts are presented for 18 research projects being conducted by the Environmental Research Branch. The following groups are involved in the investigations: biology and physical studies (6 abstracts); meteorological studies (2 abstracts); chemical studies (8 abstracts); and soil studies and radiochemical analysis (2 abstracts). Lists of branch staff members and staff lectures and publications during the reporting period are also included. (E.R.B.)

41876 (AECL–3430, pp 33-44) HEALTH PHYSICS RESEARCH. Cowper, G. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.).

Abstracts are presented for 20 research projects conducted by the Health Physics Branch during the reporting period. Areas of investigation included: neutron dosimetry; tritium detectors; and a variety of counters, detectors, dosimeters, and health instruments in progress. The results of routine personnel dose monitoring during the reporting period are presented in tabular form. Lists of staff members and staff publications are also included. (E.R.B.)

41877 (ANL–7635, pp 200-28) BIOCHEMISTRY. (Argonne National Lab., Ill.).

Beta spectra of toluene labeled with ^{14}C and tritium were examined in a liquid scintillation counter coupled to a multichannel analyzer. The advantage of this method is that the data may be handled by existing computer routines for statistical analysis and on-line plotting of spectra. Curve-fitting was successful in describing samples with moderate losses in radiocarbon efficiency and extensive losses in tritium. Other biochemical studies included enzymatic activity of yeast cell ghosts; stability of the glycosidic bond of S-adenosylsulfonium compounds toward acid; and metabolism of mitochondrial proteins. (H.L.W.)

41878 (BRH/DBE–70-1, pp 23-34) DEMOGRAPHIC STUDIES SECTION. (Public Health Service, Rockville, Md.).

The Demographic Studies section is concerned with the planning, execution, and analysis of studies of human populations exposed to radiation. The 1964 X-Ray Exposure Study was conducted to estimate x-ray exposure and dose for the general population based upon the x-ray experience of a representative sample of the U. S. population. A statistical model was developed for estimating the genetically significant radiation dose to the U. S. population attributable to medical x rays for the period 1965 to 1990. Genetically significant doses of diagnostic x rays were compared for populations of the U. S., Sweden, Denmark, and New Zealand. (H.L.W.)

41879 (BRH/DBE–70-1, pp 153-72) DOSIMETRIC STUDIES SECTION. (Public Health Service, Rockville, Md.).

Dosimetric studies on microwave irradiation included research projects on energy absorption by dielectrics in a capacitor; electrical properties of commercial insulators; and temperature controller design for a digital glow-curve analyzer. Dosimetric studies on x irradiation included research projects on tinea capitis dosimetry; color TV radiation dosimetry; age sensitivity of Chinese hamsters; and dose rate effects. (H.L.W.)

41880 (N–69-13643) ENERGY DEPOSITION IN MICROSCOPIC VOLUMES BY HIGH-ENERGY PROTONS. Hilbert, Jerald W.; Baily, Norman A. (Emory Univ., Atlanta, Ga. Dept. of Radiology). [1968]. 24p. (NASA-CR–97911). CFSTI.

Measurements of the frequency distributions of the energy deposited as the result of the passage of high-energy protons through microscopic volumes of biological interest present some unique problems. A method is described that permits the determination of such distributions in arbitrarily shaped volumes having dimensions equivalent to fractions of a micron of unit-density tissue. The method is illustrated for a 1.77 micron diameter tissue sphere, irradiated with 40 MeV protons, and implications to other energies and geometries are made in terms of the generalizations possible from these results. Distributions for various depths in a tissue-like phantom are also presented. (STAR)

41881 TISSUE DOSAGE FROM A POINT SOURCE OF FISSION NEUTRONS IN AIR. Goryachev, I. V.; Zeinalov, E. I.; Kukhtevich, V. I.; Obaturov, G. M.; Trykov, L. A.; Shalin, V. A. This paper was summarized in At. Energ. (USSR); 26: 542-3 (Jun 1969) as paper No. 310. (In Russian).

The distribution with depth of the absorbed dose of neutrons and γ rays in a tissue-equivalent ellipsoidal dummy of the human body was investigated. Depth distribution measurements were made of the dose of recoil protons, protons from the reaction ^{14}N(n,p)^{14}C and γ rays in the dummy located with its chest towards the source. In addition, measurements were made of the energy distribution of fast neutrons ($E_n > 0.1$ MeV), and of the recoil protons at various points inside the dummy. The recording of the neutrons and recoil protons was done by means of a scintillation spectrometer with a single stilbene crystal. The distribution of thermal neutrons was investigated using glass tracking dosimeters, based on ^{235}U, and the γ rays were recorded by means of film dosimeters. (auth)

41882 INVESTIGATION OF X RADIATION FROM COLOR TELEVISION RECEIVERS IN SUFFOLK COUNTY, NEW YORK. Becker, Seymour (Suffolk County Dept. of Health, Riverhead, N. Y.). Radiol. Health Data Rep.; 11: 179-82(Apr 1970).

The results of an investigation of color television receivers at the homes of 6,482 residents in Suffolk County, who requested a radiation inspection after publication of the proposed study in the newspapers, are presented. The survey consisted of two parts: an investigation of only General Electric color television sets from July 1967 through August 1967; and a radiation inspection of General Electric and 39 other types of television receivers requested by owners from January 1968 to December 1969. X-radiation emissions were detected in 37 of the 40 name brands of color television sets checked. Over 1,000 (16.2 percent) color television sets emitted x radiation above the NCRP recommended guides. The x-ray emissions ranged above 0.5 mR/h to 150 mR/h at 5 cm

from the television set. X-radiation emissions were reduced to the natural background of the home by adequate modification and adjustment of the television components. (auth)

41883 PROJECTION CHEST PHANTOM FOR IN VIVO DOSIMETRY. Waite, D. A.; Andersen, B. V.; Bramson, P. E. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Amer. Ind. Hyg. Ass. J.; 31: 322-6(May-Jun 1970).

A unique projection chest phantom was constructed of very inexpensive materials. This phantom provides for complete variability of chest thickness and incorporates bone structures of a bone-equivalent substance. The phantom contains lung cavities in which doped artificial lungs can simulate any possible lung deposition. The phantom is designed to be especially useful for calibration of in vivo lung counters when measuring low-energy x rays and γ rays (10 to 100 keV). Construction details and a comparison of results with those obtained using a commercial phantom show a reasonable relationship and demonstrate the usefulness of the projection concept. (auth)

41884 ESTIMATE OF THE INHALATION HAZARD FROM NEUTRON-ACTIVATED CONCRETE DUST. Cember, Herman; Smith, Richard W.; Oestmann, Mary Jane (Northwestern Univ., Evanston, Ill. Argonne National Lab., Evanston, Ill.). Amer. Ind. Hyg. Ass. J.; 31: 327-30(May-Jun 1970).

An evaluation was made of the radiological health hazard arising from inhalation of radioactive concrete dust, from a barytes aggregate concrete used for nuclear reactor shielding. This study involved: generation of airborne concrete dust particulates, collection, and sizing of the particulates; thermal neutron irradiation of the dust samples; and measurement of the induced radioactivity samples. It was found that inhalation of airborne activated concrete dust for several hours, at concentrations that may be encountered in practice, may be hazardous by ICRP occupational safety criteria, unless appropriate action is taken to reduce exposure. (auth)

41885 ADMINISTRATION OF AN IN VIVO COUNTING PROGRAM. Kalmon, Ben (Goodyear Atomic Corp., Piketon, Ohio). Contract AT(33-2)-1. Amer. Ind. Hyg. Ass. J.; 31: 353-7(May-Jun 1970).

The administration of an in vivo counting program as applied to insoluble uranium compounds with the lung as the critical organ is described. Criteria for restricting work activities, and for removal from work restrictions, as well as the derivation of the lung burden and the weight of ^{235}U equivalent to one lung burden are presented. The methods of in vivo computation and sample calculations from data from a specific case are included. (auth)

41886 EVALUATION OF RADIATION DOSES IN ORGANISMS OF POPULATION OF NOVGORODSK REGION. Poplavskii, K. K.; Popov, I. P. (Leningrad Research Inst. of Radiation Protection). Gig. Sanit.; No. 3, 109-11(Mar 1970). (In Russian).

Effects of cosmic radiation on the population in Novgorodsk region were evaluated by studying radiation intensity in Il'men' and Valdai lakes. Data obtained revealed radiation doses under 3 m of water thickness equal to 3μ7/h resulting in yearly irradiation doses to human organisms of 25.3 mrad. The radon and thoron contents in wooden and brick dwellings were tabulated. The total dose of radiation to human gonads from various sources in the territorial Novgorodsk region was estimated to equal to 163 mrad/year with the assumption that the internal irradiation from ^{40}K, ^{14}C, ^{210}Po, and ^{222}Ra was 21.6 mrad, the γ-doses from the earth surface, air, and construction materials were 63.1 mrad/year and irradiation from medical x-rays was 53.5 mrad/year. (R.V.J.)

41887 CALCULATION OF INTEGRAL DOSES IN RADIOTHERAPY WITH A COBALT BOMB. Dubinin, Ilja; Chvojka, Zdenek (Radiologische Klinik, Brno. Radiologische Klinik, Hradec Kralove, Czech.). Sb. Ved. Pr. Lek. Fak. Karlovy Univ. Hradci Kralove; 12: 293-301(1969). (In German).

Differential equations and their integration are given for calculating the integral dose in the general case of irradiation with ^{60}Co. They are then modified for application to the special case of a tumor. Finally, as a practical example, calculation of the integral dose within the pelvic area is given for exposure through four portals. (H.B.G.)

41888 PACKAGES CONTAINING RADIOACTIVE MATERIALS IN THE RAILWAY STATION OF SALUGGIA AND RADIATIONS RECEIVED BY THE EXPOSED PERSONNEL. Susanna, A. (CNEN, Rome). Lav. Umano; 21: 161-74(1969). (In Italian). (RT/PROT-(69)42).

Radiation protection problems at the station of Saluggia (Vercelli, Italy) were studied in connection with the transport of radioactive materials by rail. A calculation of the maximum probable doses for the critical group of persons exposed to radiation is also made: it shows that, if the above mentioned persons were considered as belonging to the general public, for whom the established dose limit is 0.5 rem/year, the traffic of radioactive materials within the above station should be limited to an average of 17 packages/day. (Excerpta Med.)

41889 SUPERSONIC TRANSPORT: NO RADIATION DANGER. Allkofer, O. C.; Simon, M. (Univ., Kiel). Umschau; 69: 327-31(22 May 1969). (In German).

The type of radiation and the radiation loads to which passengers and flight personnel may be exposed are examined in connection with supersonic flight, that take place within an altitude of 19 to 25 km. The following topics are discussed: the constitution and intensity of galactic radiation and of solar radiation (including its relation to the 11 year solar cycle, solar flares and energy of solar protons); the effect of radiation upon man; radiation dosages in the supersonic region; and a comparison of radiation dosages with tolerance dosages and avoidance of short period high energy radiation from flares. Apart from high energy flares the radiation load for passengers remains below the specifications of the German radiation protection regulation for persons not subject to radiation monitoring. In the case of aircraft personnel, who are exposed to a higher mean annual radiation dose, the dose still remains below the tolerance dose for individuals exposed to radiation. If the aircraft remains at supersonic altitudes less than 35 hours per month, the radiation dose is below the dose permissible for individuals exposed to radiation. Data on the relative portion of different particles in primary galactic radiation, intensity of variation and particle composition of galactic radiation of the atmosphere, total radiation dose from a solar flare and mean annual radiation load of flight personnel of supersonic aircraft, are presented. (Meteorol. Geoastrophys. Abstr.)

41890 GRADATION OF DOSIMETRIC FILM FOR BETA PARTICLES OF VARIOUS MAXIMUM ENERGIES. Metalli, P.; Lesaca, R. M.; McCannon, D. (CSN, Casaccia, Italy). G. Fis. Sanit. Prot. Radiaz.; 12: No. 1, 28-34(1968). (In Italian).

A method is described of measuring individual film dosimetry with exposure to β particles of varying maximum energy, the sources of which consisted of simple isotope solutions. Two types of film of different sensitivity to four radioisotopes ranging in maximum energy from 0.254 to 2320 MeV were used. It was shown that the film response is so linked to energy that, when the measurement is carried out with only one energy, the absorbed dose may be underestimated. It was also shown that such underestimation occurs in the widely used method that relies solely on energy provided by natural uranium. (Excerpta Med.)

41891 DOSE RATES IN A SLAB PHANTOM FROM MONOENERGETIC GAMMA RAYS. Claiborne, H. C.; Trubey, D. K. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 8: 450-5(May 1970).

Gamma-ray flux-to-dose-rate conversion factors obtained with a philosophy consistent with that used for neutrons have not been generally available. To eliminate this inconsistency and develop more realistic γ-ray conversion factors, γ-ray dose-rate distributions were determined in a slab phantom. Calculations were made with the discrete ordinates code ANISN and by the Monte Carlo code OGRE. Agreement between calculations and the available experimental results was excellent. Based on these results, a recommended curve was prepared for use when low-level exposure is the consideration. (auth)

Radiation Protection

Refer also to abstracts 41861 and 41900.

41892 (ANL-7635, pp 186-99) RADIATION PROTECTION. (Argonne National Lab., Ill.).

Studies were conducted on effects of physical form of ^{239}Pu on tissue distribution and retention in mice, localization of ^{239}Pu in bone and liver, and effectiveness of glucan in accelerating removal of polymeric plutonium deposited in mouse liver. Biochemical changes in cartilage during calcification and ossification, particularly with regard to changes in mucopolysaccharide and mucoprotein components and the role of such substances in the accumulation of metals such as calcium and plutonium were studied. Transplantation experiments were conducted on the amoeba, Pelomyxa carolinensis, exposed to lethal ultraviolet radiation and treated with nitrogen mustard. Transplantation of unexposed, untreated protoplasm from donor amoebae replaced the damaged nuclei and presumably repaired DNA damage in exposed nuclei. The restoration of supralethally x-irradiated amoebae by protoplasm from supralethally HN2-treated amoebae is discussed. Preliminary electron microscopic observations were made on both spermatozoa and oocytes from the oyster,

Crassostrea virginica, and photographs are presented to show cytological details. (H.L.W.)

41893 SOLAR FLARE RADIATION PROTECTION REQUIREMENTS FOR PASSIVE AND ACTIVE SHIELDS. French, Francis W. (Avco Everett Research Lab., Everett, Mass.). J. Spacecraft Rockets; 7: 795-800(Jul 1970).

The degree of protection from solar flare radiations required by astronauts on a typical interplanetary flight is investigated for protection provided by a) active means (plasma radiation shielding), or b) passive means (bulk shielding). Anticipated solar flare radiation environments as proposed in several recent studies are used to relate absorbed dose at two body sites, the skin and the blood-forming organs, to the parameters of the two shielding concepts. Curves are generated of dose vs passive shield thickness and plasma radiation shielding voltage with probability of exceeding a given dose as a parameter. Maximum permissible dose levels at the two body sites of interest, and allowable probabilities of exceeding these dose levels during the missions, are specified. Requirements for the two types of shielding are tabulated. A limited comparison is made between the requirements for the two types of shielding, and data are provided for eventual broader comparisons of spacecraft that embody the two types of protection. (auth)

Safety Procedures

Refer also to abstracts 41564 and 43859.

41894 (Y-1739) MORTALITY EXPERIENCE OF URANIUM AND NONURANIUM WORKERS. Scott, L. M.; Bahler, K. W.; de la Garza, A.; Lincoln, T. A. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 31 Jul 1970. Contract W-7405-eng-26. 12p. Dep. CFSTI.

A study was made of mortality rates of uranium and nonuranium workers in two facilities processing massive quantities of uranium. The uranium worker group consisted of over 4,500 employees with a total of about 14,000 man-years of association with uranium processing. It was concluded that the mortality experience was more favorable for the uranium workers than for the nonuranium workers in the same plants during the same period. (auth)

41895 CAUSALITY AND MODALITY IN THE EVALUATION OF SKIN NEOPLASMS AS OCCUPATIONAL LESIONS. Gahlen, W. Arch. Klin. Exp. Dermatol.; 237: 420-4(1970). (In German).

From a medico-legal standpoint, the connection between professional exposure to various carcinogens and the appearance of skin cancer is discussed. Briefly outlined are problems associated with tar products, arsenic, ultraviolet and infrared radiation, and scars following third degree burns. Implications and definitions of terms such as possible, only possible, and probable are outlined. From a legal standpoint, association between professional exposure and occurrence of skin cancer has to be established only on the basis of probability, not certainty. (H.B.G.)

41896 RADIOISOTOPES IN MEDICINE. Ind. Med. Surg.: 38: No. 7, 35-45(Jul 1969).

Abbott Laboratories Radiopharmaceutical Products Division prepared and designed material for industrial physicians and their staffs. Types of isotope, the fundamental physics of radioactivity, radiation dosage units, the more common medical radioisotopes, their radiation properties and uses are reviewed. Radiation hazards and specific effects (including genetic and physical), maximum permissible doses, monitoring devices, shielding and other means of reducing exposure, precautions for nurses, dose amounts and methods of administration, and recording of doses, personal protection, and housekeeping are discussed. Radiopharmaceuticals should be used only by physicians trained in their use and handling. (auth)

41897 BIOLOGICAL AND PHYSICAL BASIS OF PROTECTION AGAINST IONIZING RADIATION. Polvani, C. (CNEN, Rome). Lav. Umano; 20: 462-5(1968). (In Italian).

The biological and physical principles of protection against radiation consist in an awareness of the risks of radiation and measurement of the extent of the risks and of the dose absorbed. The specialized abilities of doctors, physicists and chemists concerned with toxicology should be combined to obtain the best results. (Excerpta Med.)

41898 SPECTRUMS IN INDUSTRIAL HYGIENE. Barnes, E. C. (Westinghouse Electric Corp., Pittsburgh). Amer. Ind. Hyg. Ass. J.; 31: 265-76(May-Jun 1970).

The expanding role of the industrial hygienist in evaluating and controlling the increasing variety of health protection problems attendant to the burgeoning nuclear and radiation industry is discussed. The permissible exposure levels for nuclear personnel are discussed in terms of the drastic changes in biological response to slight variations in frequency within the electromagnetic and sonic spectrums. An appeal is made for fully adequate but not arbitrarily or superficially restrictive occupational health protection practices, standards, and evaluation techniques. (E.R.B.)

41899 HEALTH SURVEILLANCE OF MICROWAVE HAZARDS. Powell, Charles H.; Rose, Vernon E. (Univ. of Missouri, Columbia. Bureau of Occupational Safety and Health, Cincinnati). Amer. Ind. Hyg. Ass. J.; 31: 358-61(May-Jun 1970).

Since the early 1940's, industrial use of electronic equipment that emits electromagnetic energy in the microwave region has increased. Concurrent with this growth has been the development of data on the biological effects of this form of radiant energy and the establishment of exposure criteria. Of equal importance in protecting the health of exposed persons is the evaluation, by qualified occupational health personnel, of the electronic equipment as it is used in the workplace by reliable and accepted environmental health techniques. Various local, state, and federal health programs and survey techniques and instrumentation are reviewed. Standardization of survey techniques is suggested, and recommendations are presented regarding future activities in establishments where persons may be potentially exposed to microwaves from ovens and other commercial and industrial sources of energy. (auth)

41900 STUDY ON BACKSCATTER AT X-RAY EXPOSURE. THE RELATION BETWEEN CASSETTE AND EXPOSURE-FIELD SIZE. Nakamura, Minoru; Furuta, Yoshiyuki (Mie Univ., Shiohama, Japan). Sakura X-Rei Shashin Kenkyu; 20: No. 6, 15-17(Nov 1969). (In Japanese).

From the standpoint of reducing weight of cassette and protecting against radiation hazard, the backscatter at x-ray exposure was studied experimentally. The results obtained are as follows: The density of film increased by backscatter as the exposure field outside the cassette became larger, and it increased in proportion to the tube voltage and as the exposure dose increased. The density of film initially increased by backscatter as the cassette moved away from the wall, reached a maximum when the cassette was 20 to 30 cm away from the wall, and then decreased gradually as the cassette moved further away, irrespective of the tube voltage, exposure dose, and the presence or absence of a phantom. When the exposure field was narrowed to cassette size on its surface in the presence of a phantom, the influence of backscatter became nil. When the exposure field was narrowed to cassette size in the absence of a phantom, the blackening by backscatter was very slight even in the exposure of 200 mAs at 70 kVp, and it was not observed in the exposure up to about 50 mAs at 100 kVp and up to about 20 mAs at 130 kVp. It is concluded that radiographs should be taken by narrowing the exposure field as much as possible, and by placing a cassette closer to the wall or more than one meter away from the wall. (NSA of Japan)

41901 HEALTH CONSIDERATIONS IN THE USE OF ORGANIC REACTOR COOLANTS. Weeks, J. L.; Lentle, B. C. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). J. Occup. Med.; 12: 246-52(Jul 1970).

The toxicology of the biphenyl and terphenyl reactor coolants is briefly discussed and the maximum permissible exposure and concentration levels for reactor personnel, as proposed by the CRNL Medical Division staff, are summarized. Clinical investigations of the medical aspects of organic coolant use are described and results are presented in terms of exposure to irradiated and nonirradiated coolants. The effects of unirradiated terphenyl are renal and pulmonary while those of irradiated terphenyl are hepatic. The possible effects of acute overexposure to these coolants include: pulmonary damage; damage to skin; burns; and damage to the eyes. (E.R.B.)

Legal Aspects

41902 (FMRB-18) STANDARD VALUES FOR PERMISSIBLE CONTAMINATION OF SURFACES WITH RADIOACTIVE MATERIALS. Kriks, H.-J. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Apr 1968. 13p. (In German). Dep. CFSTI (U. S. Sales Only).

No international legal standards were established thus far for the definition of contaminated surfaces from a health physics standpoint. Presently existing regulations were compiled and tabulated for France, Poland, England, USA, USSR, Austria, and Germany. In addition, the most important radioisotopes were

analyzed as to permissible activity and classification of toxicity corresponding to minimum significant quantity. (H.B.G.)

41903 RADIATION PROTECTION REGULATIONS NEED REVISION. Isola, Aulis. Sairaanhoitaja; 45: 20-1(13 Jan 1969). (In Finish).

On July 1, 1968, all matters pertaining to health care, nursing and sale of drugs were transferred to the Ministry of Health and Welfare; at the same time, that agency was charged with the responsibility to administer radiation protection measures. On December 1, 1968, a new regulation went into effect, establishing the maximum permissible levels of radiation, superseding three previous laws on this subject. The new maximum permissible levels agree with the values recommended by the International Commission on Radiological Protection. (TTT)

41904 STANDARDS NEEDS IN CONTROLLING RADIATION EXPOSURE OF THE PUBLIC. Snow, Donald L. (Public Health Service, Rockville, Md.). Amer. J. Public Health; 60: 243-9 (Feb 1970).

A number of needs were identified for standards that will minimize the public exposure to both ionizing and nonionizing radiation. Such needs include, in addition to electronic products-related standards, criteria on which the standard can be based; further guidance for setting emission or exposure standards in the case of multiple number of sources of ionizing radiation exposure or electronic products emitting ionizing radiation; and further instrumentation or data collection methodology to promote uniformity and comparability of exposure data. (auth)

41905 LICENSING OF RADIOACTIVE MATERIALS IN INDUSTRY. Ely, Thomas S. (Eastman Kodak Co., Rochester, N. Y.). Arch. Environ. Health; 21: 200-2(Aug 1970).

The licensing of radioactive materials or radiation sources in industry is discussed. A brief review is given of the historical aspects of state and federal regulations regarding licensing, and several publications relating to occupational exposure standards and procedures for obtaining a license are suggested. The role of the industrial physician in meeting the requirements for industrial licensing of radioactive materials is emphasized. (E.R.B.)

41906 DECREE OF 27 NOVEMBER 1952 AND ITS APPLICATION TO NUCLEAR POWER STATIONS. Rosay, J.; Hantz, R. Secur. Med. Trav.; No. 2, 13-21(Mar-Apr 1969). (In French).

Because of the special working conditions involved, implementation of the provisions of the decree concerning the function and responsibilities of the industrial physician at nuclear power stations is very difficult. He is unable to ensure adequate medical surveillance unaided because of the diverse workplaces and controls necessary. The complex organization entailed by this work is described and details of procedure at the Fontenay-aux-Roses nuclear power station in France are given where a Health and Safety section was created in 1960 under the direction of the chief medical officer. His main working aid is a card index providing a record of harmful working conditions, radiation doses and examinations for each worker. A balance sheet is presented of activities during the past 5 years (frequent inspection of workplaces, study of working environment, education and training of workers and decontamination). Figures given demonstrate the value of such an organisation to the industrial physician in his role as consultant to management and workers. (Occup. Safety and Health Abstr.)

Medicine

Refer also to abstracts 41617, 41620, and 41896.

Protective Substances

Refer also to abstracts 41297, 41769, 41770, 41897, 41949, 41975, 42032, and 42042.

41907 PROTECTIVE EFFECT OF SODIUM FLUOROACETATE ON HAEMOPOIETIC STEM CELLS OF IRRADIATED MICE. Vacek, A.; Sikulova, Jarmila; Davidova, Eva; Novak, L.; Filip, J. (Inst. of Biophysics, Brno). Folia Biol. (Prague); 16: 129-36(1970).

The effect of time interval between sodium fluoroacetate (FAc) administration and irradiation upon the number of endogenous haemopoietic colonies in the spleen (ESC) was investigated in irradiated mice. Maximum values of ESC were found when the injection of FAc preceded by 1 hour the exposure to radiation. The protective effect of FAc resulting in an increased survival of haemopoietic stem cells was observed after the exposure both in vivo and in vitro. Irradiation in oxygen at normal barometric pressure did not affect the protective action of FAc on ECS, while exposure under hypoxia potentiated the effect. FAc administration to mice was accompanied by a reduction of oxygen tension in the spleen, a decrease in rectal temperature, and a transient inhibition of the proliferative capacity of haemopoietic stem cells in the bone marrow and particularly in the spleen. A comparison with other radioprotective substances revealed that the inhibition of the proliferative capacity of haemopoietic stem cells was a common effect and was therefore not specific for FAc. (auth)

41908 MAGNETIC FIELDS AND THE NUMBER OF BLOOD PLATELETS. Barnothy, M. F. (Univ. of Illinois, Chicago); Barnothy, J. M. Nature (London); 225: 1146-7(21 Mar 1970).

It is stated that a beneficial effect was obtained in mice radiation syndromes by exposure to magnetic fields before irradiating (see Nature 181:1785 (1958)); this may have been due to an increased number of platelets in the circulating blood after the magnetic exposure. The increased number of platelets may have reduced the death rate from intestinal haemorrhages. (UK)

41909 EFFECT OF ALGINIC ACID ON THE DEPOSITION OF ^{90}Sr AND ^{45}Ca IN THE BODY IN CASE OF LONG INTAKE. Dolmatova, M. Yu.; Dubrovina, Z. V. Gig. Sanit.; No. 3, 40-3 (Mar 1970). (In Russian).

A long-term experiment carried out with adult rats showed alginic acid to have a high protective effect against the action of radioactive strontium. However, this effect diminished eventually. Alginic acid was noted to affect selectively radioactive strontium in comparison with calcium. (auth)

41910 EFFECT OF INTESTINE IRRADIATION IN THE ABSENCE OF SODIUM ON THE OXYGEN UPTAKE. Jordana, R.; Ponz, F. (Univ. of Navarra, Pamplona, Spain). Rev. Espan. Fisiol.; 26: 167-70(Jun 1970).

The effect of x-irradiation (20,000 r) was studied in vitro in jejunum strips preincubated in medium without sodium over the posterior oxygen uptake of the tissue in medium with sodium, with and without glucose. Irradiation under these conditions inhibits oxygen consumption by the tissue, oxygen uptake reached values much lower than those obtained with equal dosage of irradiation combined with medium with sodium. The inhibition produced by irradiation and that produced by preincubation in medium without sodium added their effects when these factors acted simultaneously. (auth)

41911 ENHANCEMENT OF RADIORESISANCE IN MICE TREATED WITH DIPHENYLHYDANTOIN. Levan, H. (Veterans Administration Hospital, Hines, Ill.). J. Pharm. Sci.; 59: 1178-9(Aug 1970).

Diphenylhydantoin, a pharmaceutical compound of the same chemical class as magnesium pemoline, is found to exhibit significant protection against ionizing radiations. It is suggested that the mechanism of the radioprotective action of diphenylhydantoin is related to its influence on nucleic acid metabolism rather than to its anticonvulsant effects on the brain. (auth)

41912 INFLUENCE OF CERTAIN RADIOPROTECTIVE CHEMICALS ON THE MOUSE'S RESPONSE TO TOURNIQUET INJURY. Einheber, Albert; Wren, Robert E.; Klobukowski, Christopher J. (Walter Reed Army Medical Center, Washington, D. C.). J. Trauma; 10: 322-30(Apr 1970).

Experiments were performed to determine whether treatment of mice with certain radioprotective chemicals influences their ability to survive tourniquet-induced injury, when they have been given no treatment for the effects of the injury per se or when they have been given ordinarily effective shock therapy in the form of 0.9% saline. Tourniquets were applied to both hind legs for periods of 1.0, 1.5, or 2.0 hr. Fifteen min before removal of the tourniquets, the mice were given radioprotective doses of either beta-mercaptoethylamine · HCl (MEA) or S-2(3-amino-propylamino) ethyl phosphorothioic acid · $3H_2O$ (WR 2721C) alone or a combination of MEA and S-ethylisothiouronium · HBr (WR 539). Treatment with these agents significantly shortened survival time and increased mortality during 48 hr after tourniquet removal. Massive saline therapy administered intraperitoneally to the radioprotectant-treated, injured mice immediately after tourniquet removal significantly increased their survival rate, virtually to that of the corresponding mice that had received no radioprotectant. Radioprotectant-treated, uninjured mice given massive saline therapy and those given none before exposure to ordinarily lethal whole-body γ- or x radiation were equally protected against the lethal effects of irradiation. (auth)

Radiation Sickness and Injuries

Refer also to abstracts 41757, 41782, 41947, 41988, and 42000.

41913 SURGICAL POSSIBILITIES OF SKIN-SOFT PART GRAFTING IN RADIATION INJURY. Georg-Pforzheim, H. Langenbecks Arch. Chir.; 325: 998-1006(1969). (In German).

In more extensive radiation damage to the skin good results can be achieved in nearly all cases by the use of the classic method of skin replacement by slide flaps according to Dieffenbach and by rotation or stretch flaps according to Imre–Blaskowiez. The examples shown are exclusively of patients in whom a histologically confirmed malignant tumor was removed by radiation. After excision of the tissue damaged by radiation no remnants of tumor could be demonstrated histologically. The radiation damage itself could be made good by plastic skin replacement. (auth)

41914 TERMINAL ILEUM AS URETERAL SUBSTITUTE. Krupp, Philip; Hoffman, Milton; Roeling, William (Tulane Univ., New Orleans). Obstet. Gynecol.; 35: 416-26(Mar 1970).

An ileal substitute was used to replace the pelvic ureter in 19 patients, 18 with carcinoma of the cervix; 21 ureters were replaced. By all functional and morphologic criteria the procedure was judged feasible and practical. There was one postoperative death due to septic shock. As long as functioning renal tissue remains above the diseased ureter, such ileal substitution is recommended when the ureter must be removed or when ureteral fistula of an intensely irradiated patient is to be repaired. (auth)

Radiodiagnosis

Refer also to abstracts 41668, 41680, 41682, 41684, 41729, 41751, 41878, 41900, 42001, and 42012.

41915 RENTGENODIAGNOSTIKA V AKUSHERSTVE. (X-Ray Diagnostics in Obstetrics). Demidkin, P. N. Moscow; Izdatel'stvo Meditsina (1969). 272p.

The monograph is the first major work in Russian literature dealing with x-ray diagnostics in obstetrics. All areas of obstetrics, including pathology, are discussed in the light of contemporary knowledge. Using x-ray techniques, it is possible to resolve such important clinical questions as the determination of placental presentation, the study of shape and dimension of the pelvis, determination of the proportions of the head of the fetus and the pelvis of the mother, the presence of malformations of the fetus, and changes in the woman after cesarian section. Using x-ray techniques it is possible also to diagnose the prenatal death of the fetus, changes in the pelvic articulation, multiple pregnancies, positions, shape and position of the parts of the fetus, and the degree of its maturity. The methodology and technology of radiological investigations in different obstetrical pathologies and effects and contraindications in the application of x rays in obstetrics are given in detail. The book is based on a large amount of factual material and the analysis of both Russian and foreign literature, and is richly illustrated with radiograms. The monograph is designed for wide range medical radiology in obstetrics and gynecology. It is of interest both to the physician and the scientist. (tr-auth)

41916 RADIOISOTOPE DIAGNOSIS OF TUMORS OF THE BONES. Knish, I. T.; Tolstopyatov, B. A.; Kindzelskii, L. P.; Mechev, D. S. Ortop., Travmatol. Prot.; 29: No. 12, 18-23 (1968). (In Russian).

The results of experimental studies with osteotropic isotopes of ^{67}Ga and ^{85}Sr of Russian production are presented. Gallium isotope was found to exert an irritating and depressing effect on hemopoiesis; in view of this, it was not used in the clinic. Strontium 85 was employed at the clinic in the differential diagnosis of tumors of the bone system in 48 patients (20 with malignant and 15 with benign skeletal tumors). In 13 patients the preliminary diagnosis of neoplastic process was not confirmed. Strontium-85 in doses of 0.8 to 1 μCi/kg body weight failed to induce any side effects in the human organism and had no influence on hemopoiesis. As a rule, accumulation of strontium in malignant tumors was 2 to 3 times higher than in benign tumors. Scanning enables accurate definition of the extent of the neoplastic lesion. The bone seeking strontium isotope can thus be useful for radioindication of tumors of the osseous system in the systematic examination of patients. (Excerpta Med.)

41917 MEASURING THE HUMAN HEART WITH A REAL-TIME COMPUTING SYSTEM. Covvey, H. Dominic (Toronto General Hospital). Data Proces. Mag.; 12: No. 5, 27-8; 30; 32 (May 1970).

Analyzing the muscular dynamics of the human heart has become a routine procedure with the aid of a small digital computer that functions both as a data acquisition system and as a processor of data taken from x-ray moving-picture images. Doctors at the Cardiovascular Investigation Unit of the Toronto General Hospital [illegible] volume and width of a patient's left ventricle much quicker than by previous manual methods. Now numerical processing of the pictures takes 3 to 4 hr. But in several months they will be able to view—on line and real time—a volume-versus-time trace of the ventricle's performance as the patient is x-rayed. Like many other data processing applications, the shrinking of elapsed time brings particular benefits. In the case of cardiovascular treatments, doctors will be able to immediately observe how drugs affect the performance of the patient's ventricle. (auth)

41918 PREPARATION OF METABOLIZABLE RADIOACTIVE HUMAN SERUM ALBUMIN MICROSPHERES FOR STUDIES OF THE CIRCULATION. Zolle, I.; Rhodes, B. A.; Wagner, H. N. Jr. (Johns Hopkins Medical Institutions, Baltimore). Int. J. Appl. Radiat. Isotop.; 21: 155-67(Mar 1970).

Radioactive microspheres were prepared from human serum albumin (HSA) in sizes between 12 and 44 μ. These microspheres are degraded within the body after injection, and the rate of degradation can be varied by changes in the method of preparation. The microspheres can be easily labeled with various radionuclides. When injected intravenously more than 90 per cent of the microspheres are extracted by the capillary bed of the lungs. HSA microspheres have advantages over other particles that are being used for studies of the circulation. (auth) (UK)

41919 LIMITS OF VISIBILITY IN SCINTIGRAPHY OF THE RENAL MODULE. Del Vecchio, E. (Univ., Naples); Dragoni, G.; Fava, G.; Verrengia, F. Nunt. Radiol., 33: 1221-33(Oct. 1967). (In Italian).

The recording systems used in renal scintigraphy and the most usual experimental techniques are described. Experimental studies comparing the various systems, carried out on phantoms, were reported. The results showed that photographic scintigraphy with magnetic memory is the best of the methods presently available on a large scale. Its precision is much greater than that of other methods, including color scintigraphy. The magnetic memory method can detect nodules in the radioactive renal parenchyma with dimensions of 1.8 cm or larger. (J.S.R.)

41920 DECISION PROCESS EMPLOYING RADIOISOTOPE SCANNING. Nash, T. Robert (Vanderbilt Univ., Nashville). Acta Radiol., Suppl.; No. 288, 66p(1969).

If radioisotope observations are to be employed effectively, three distinct facets of the decision process that can result in therapeutic treatment must necessarily be considered and be combined properly. The first important aspect of the process is the relation between the instrumentation and the observed radioisotope emission. Thus, the mean observed emission and its associated standard deviation must be found in terms of basic instrumental attributes and the isotope dosage. The relation existing between the possible patient classes and the radioisotope emission constitutes the second aspect of the process that must be taken into consideration. Finally, the effects of the various possible therapeutic treatments must be considered. If these three factors, the instrumental influence, the distribution of radioisotope emission with respect to patient class, and the effect of the therapeutic treatments, are properly combined, a sound decision process can be established. This idea of a decision process, in which all relevant aspects are combined, should help to place various observing techniques in perspective (auth) (SW)

41921 EFFECT OF RADIATION THERAPY ON NORMAL HUMAN LYMPH NODES AND TRUNKS: EVALUATION BY "SECOND-LOOK" LYMPHOGRAPHY. Thornbury, John R. Progr. Clin. Cancer; 4: 272-7(1970).

Second-look lymphography is the radiographic reevaluation of the lymphatic system by repeat intralymphatic injection of contrast material after an interval of time has elapsed following an initial lymphogram study. This technic makes possible an objective in vivo comparison of lymph flow patterns and lymph node configuration before and after radio-therapy, using the first lymphogram as a base-line reference. Most often this type of lymphography is used to assess the effectiveness of irradiation control of cancer by showing change in the radiographic appearance of the abnormal node and trunk configuration. However, second-look lymphography also makes possible the evaluation of effects of cancerocidal radiotherapy on normal lymphatic trunks and lymph nodes in patients with localized disease. (auth)

41922 EXPERIMENTAL TECHNIQUE OF IN VIVO HIGH RESOLUTION MICROANGIOGRAPHY. Kormano, Martti (Univ. of Helsinki). Brit. J. Radiol.; 43: 180-4(Mar 1970).

A method of in vivo microangiography is described. It consists of intravenous injection of colloidal thorium dioxide into an experimental animal. After the injection, the organ to be investigated is rapidly frozen with liquid nitrogen, sectioned and radio-

graphed frozen. With this method a microangiographic visualisation of small blood vessels down to the arteriolar or even capillary level is obtained and the in situ distribution of the contrast medium within the blood vessels can be studied. (auth) (UK)

41923 DIAGNOSTIC EFFICACY OF A RADIOIODINATED CHLOROQUINE ANALOG IN PATIENTS WITH MALIGNANT MELANOMA. Boyd, Charles M.; Lieberman, Lionel M.; Beierwaltes, William H.; Varma, Vijay M. (Univ. of Michigan Medical Center, Ann Arbor). Contract AT(11-1)-2031. J. Nucl. Med.; 11: 479-86(Aug 1970).

Radioiodinated chloroquine analog has been helpful in diagnostic use in many patients with malignant melanoma. Therefore, ^{125}I-NM-113 is of significant therapeutic value in the evaluation of melanoma patients by providing the surgeon with valuable preoperative information and by helping to direct methods of therapy. It may be of use in following patients with known disease to delineate areas of spread previously unsuspected, thus guiding further treatment. (auth)

41924 RAPID HEART POOL SCANNING. Goodyear, Margaret L. (Arlington Hospital, Va.). J. Nucl. Med.; 11: 514-15 (Aug 1970).

A satisfactory heart pool scan for the demonstration of pericardial effusions was obtained with the scintillation camera using ^{99m}Tc-sulfur colloid. (E.R.B.)

41925 PROGRESS IN LYMPHOLOGY. II. Selected Papers of the Second International Congress of Lymphology, Miami Beach, Florida, March 15-20, 1968. Viamonte, Manuel; Koehler, P. Ruben; Witte, Marlys; Witte, Charles (eds.). New York; Intercontinental Medical Book Corporation (1970). 303p. $30.25. (CONF-680311).

Separate abstracts were prepared on eight papers. Other papers discuss various aspects of clinical and experimental lymphology. (C.H.)

For abstracts of individual papers see: 41780, 41926, 41942–41944, 41978, 41979, and 42013.

41926 DIAGNOSTIC AND THERAPEUTIC IMPLICATIONS OF THE LYMPHANGIOGRAM IN THE TREATMENT AND PROGNOSIS OF HODGKIN'S DISEASE. Lee, B. J.; Stephenson, P. (Memorial Hospital, New York). pp 281-4 of Progress in Lymphology. II. /Viamonte, Manuel (ed.). New York; Intercontinental Medical Book Corporation (1970).

From 2nd International Congress of Lymphology, Miami Beach, Fla. See CONF-680311.

The lymphangiogram has been a useful and practical diagnostic procedure in that it has delineated a group of patients with generalized nodal disease, who by all other criteria would appear to have a localized process and would be classified as Stage I or II. The lymphangiogram converts these patients to Stage III, and many of these patients appear to benefit from extended port high dose radiation therapy to an inverted Y shaped port. Other conclusions that can be drawn at this time are as follows. Stage I and IIA patients appear to do well regardless of mode of radiation therapy, and a negative lymphangiogram indeed proves to be an excellent prognostic sign. The value of high dose extended port radiation therapy is most evident for those patients with generalized symptomatic disease. (auth)

41927 RADIOISOTOPE SCANNING IN THE DIAGNOSIS OF LIVER ABSCESS. Pai, Soo Tong (Univ. of Malaya, Kuala Lumpur, Malaysia); Bakk, Yong Whee. Amer. J. Surg.; 119: 330-3(Mar 1970).

Liver abscess is an important clinical condition in many Asian-Pacific countries because of its common incidence and high mortality if undetected and untreated. Because of its anatomic location and bulk, early diagnosis of liver abscess is often a very difficult clinical problem. Progress in the field of nuclear medicine during the past decade has made radioisotope scanning of the liver one of the most useful methods in the differential diagnosis of suspected disease in the hepatic area. This report is based on our experiences with liver scanning in the diagnosis of hepatic disease over the past five yrs. (auth)

41928 MERITS AND LIMITATIONS OF CEREBRAL SCANNING IN NEUROSURGICAL DIAGNOSIS. Gonsette, R.; Kremer, P.; Andre-Balisaux, G. (Institut Neurologique Belge, Brussels). J. Belg. Radiol.; 53: 119-31(Mar-Apr 1970). (In French).

Utilization of radioisotopes in the neurosurgical diagnosis in a series of 2000 cases is reported. By comparison of the manual point by point recording and of the linear recording (scanning) in the same patient it is concluded that cerebral scanning is superior from two different aspects: improved detection of the lesions in general and more accurate localization in particular. An experimental study in animals leads to the conclusion that the conditions of passage of the isotopes at the level of a cerebral lesion are based on at least two phenomenons: the participation to the circulation of the interstitial liquids (Starling's flow) and impairment of the capillary permeability (lesion of the hemato-encephalic barrier). By application of this hypothesis in man, based on the utilization of different isotopes and each responding to one of these physiologic phenomenons, the lesion can be detected in a higher proportion of cases. This technique also allows a better judgement as to the nature of the lesion. (auth)

41929 TECHNICAL IMPROVEMENTS IN RENAL SCANNING. Byrom, H.; Dean, P. M.; Sear, R.; Turnbull, A. L. (London Hospital). Proc. Roy. Soc. Med.; 63: 331-6(Apr 1970).

By some simple modifications of the technique of scanning, considerable improvements in the quality of the scans were obtained. Such scans provide a useful index of renal function, but do not even now provide a reliable means of differentiating between cysts and tumors. (auth)

41930 SCINTIGRAPHY OF NON-TOXIC NODULAR AND OF MALIGNANT GOITRE. Schacht, U.; Mannfeld, U. (Ruhr Univ., Essen). Deut. Med. Wochenschr.; 95: 1521-3(17 Jul 1970). (In German).

Pre-operative scintigraphy with ^{131}I was performed on 528 patients who subsequently had thyroid surgery. More or less inactive nodules were found in 176; in 5.7% of them a malignant thyroid tumor was demonstrated (excluding malignant cases, nodules were demonstrated in 1.1% of the whole group). It is suggested that in all patients over 40 years of age with nodular goiters scintigraphy and clinical examinations should be regularly undertaken. (auth)

41931 RELIABILITY OF RADIOACTIVE PHOSPHORUS UPTAKE TEST AFTER OCULAR SURGERY. Solomon, O. David; Gans, Jerome A.; Levine, Bennett (Mount Sinai Hospital, Cleveland). Amer. J. Ophthalmol.; 70: 281-4(Aug 1970).

When the ^{32}P uptake test was done on 66 eyes six to 10 weeks after ocular surgery, positive uptake occurred throughout the 10 weeks. This test for malignancy is thus invalid in the postoperative period. However, the test is useful when done eight weeks after surgery and the criterion for a positive response is raised to 200% from 130%. (auth)

41932 SYMPOSIUM ON NUCLEAR MEDICINE IN INTERNAL MEDICINE. 1. RADIOISOTOPE APPLICATION IN DIAGNOSIS OF CARDIOPULMONARY DISEASES. Murao, Satoru (Tokyo Univ.). Jap. J. Med.; 8: 201-3(Jul 1969).

The application of radioisotopes in diagnosis and the clinical research on cardiopulmonary diseases carried out in the Department of Internal Medicine, University of Tokyo, are outlined. The topics discussed include: radioisotope indicator-dilution method using ^{131}I-Hippuran for the hemodynamic study of congestive heart failure; radioisotope scanning of the heart such as cardiac blood pool scanning with RISA, ^{99m}Tc or ^{113}In, and photoscanning of cardiac muscle using ^{137}Cs for the direct visualization of myocardial infarct; radioisotope angiography using a gamma-camera with two multistage image tubes devised in the Department; studies of regional pulmonary circulation with ^{131}I-MAA; development of a catheter-type semiconductor radiation detector for in vivo measurement of the β radioactivity of ^{85}Kr in blood and tissue; and study of digitalis metabolism with ^{3}H-digoxin. (NSA of Japan)

41933 CLEARANCE OF ^{133}Xe OR ASSESSMENT OF CHANGES IN PERIPHERAL ARTERIAL FLOW AFTER HYPEREMIA-INDUCING THERAPY. Rossotto, P.; Stancanelli, V.; Georgacopulo, P. (Univ., Ferrara, Italy). Settim. Med.; 56: 1025-9 (1968). (In Italian).

The ^{133}Xe clearance technique was used in the evaluation of changes in the peripheral arterial flow following anesthetic infiltration or interruption of the lumbar sympathetic, or following corrective surgery or intraarterial therapy. The results in a group of arteriopathic patients are presented, and the advantages of this technique over other methods are emphasized. (Excerpta Med.)

41934 SYMPOSIUM ON NUCLEAR MEDICINE IN INTERNAL MEDICINE. 4. THE SIGNIFICANCE OF THE USE OF RADIOISOTOPES IN THE GASTROINTESTINAL DISEASES. Yamagata, Shoichi (Tohoku Univ., Sendai). Jap. J. Med.; 8: 211-12(Jul 1969).

The significance of radioisotopes in the diagnosis of gastrointestinal diseases was evaluated in the following gastrointestinal function tests: RIHSA test using Piper's method for the measurement of pepsin activity proved to be no more useful than the hemoglobin method. ^{131}I-triolein test and ^{131}I-oleic acid test were per-

formed in patients with steatorrhea with either pancreatic or intestinal diseases. In the case of pancreatic disease, ^{131}I-triolein test indicated a high fecal radioactivity while ^{131}I-oleic acid showed normal values. Abnormal results were obtained for both tests in patients with intestinal diseases. ^{131}I-PVP test was suggested to be useful for differentiating protein-losing enteropathy from malabsorption syndrome or the coexistence of the two diseases. ^{75}Se-selenomethionine photoscans of the pancreas proved to be particularly useful for the detection of pancreas body cancer for which clinical diagnosis is difficult using the ordinary secretin test or cytological examinations. Other tests discussed include the ^{51}Cr-labeled red cell tracing method and the ^{59}Fe absorption test. (NSA of Japan)

Radiotherapy

Refer also to abstracts 41698, 41797, 41887, 41992, 41998, 41999, 42002, 42005, 42007, 42008, 42013, 42017–42024, 42033, and 43091.

41935 DEUTSCHER ROENTGENKONGRESS 1969. Referate Ueber die 50. Tagung der Deutschen Roentgengessellschaft. Gesellschaft fuer Medizinische Radiologie, Strahlenbiologie und Nuklearmedizin e. V. vom 8. bis 11. Mai 1969 in Stuttgart. (German Roentgen Congress 1969. References on the 50th Meeting of the German Roentgen Society. Society for Medical Radiology, Radiation Biology, and Nuclear Medicine, Stuttgart, May 8–11, 1969). Glauner, Rolf (ed.). Fortschr. Geb. Roentgenstr. Nuklearmed., Suppl.; 1-94(1970). (CONF-690551–(Absts.)).

Presented were: six papers on angiographic and scintigraphic studies in diseases of bones and joints; twelve papers on intraossary venography of the femur head; fourteen papers on physics and technique; five papers on radiologic examination in patients with malignant tumors of pelvic organs with the exception of primary gynecological malignancies; eighteen papers on radiation therapy of malignant pelvic tumors with the exception of gynecological neoplasms; four papers on radiotherapy of urinary bladder carcinoma; two papers on radiation therapy with neutrons; twenty-two papers on radiological examinations of patients with myocardial diseases. Seventeen separate abstracts were prepared for the section on radiobiology with emphasis on biochemically detectable radiation effects and their significance for radiotherapy. (H.B.G.)

41936 RADIOACTIVE IMPLANTS OF THE PITUITARY FOR ENDOCRINE DISEASE. Forrest, A. P. M.; Thomas, J. P.; Richards, S. H.; Wood, R. G.; Stewart, H. J.; Gleave, E. N.; Greenwood, F. C. (Royal Infirmary, Cardiff, Wales). Proc. Roy. Soc. Med.; 63: 616-18(Jun 1970).

From a study of 27 acromegalic patients, it was concluded that ^{90}Y and/or ^{198}Au (planned to deliver not more than 10,000 rads to the roof of the pituitary fossa by transnasal implantation) was less effective treatment than surgical removal of the pituitary gland. Implantation of ^{198}Au was also used to treat pituitary type Cushing's disease. Of six patients with primary Cushing's disease, but normal sized pituitary fossa, one had a partial response, four had complete remission and the sixth had none. One patient with an invasive tumour died after no remission. Of two patients with previous adrenalectomies, one had no improvement after an implant of ^{90}Y (10 mCi), but remission occurred after an implant of ^{198}Au (25.4 mCi). The second had partial remission after an implant of 39 mCi of ^{198}Au. It was concluded that gold implantation can give remission of Cushing's syndrome, but that such an isotope should be used only if it can be removed should the calculated dose exceed that originally planned, since the occurrence of recent side effects. (UK)

41937 TOTAL BRAIN THERAPY: TECHNICAL CONSIDERATIONS. Green, Nathan; George III, Frederick (Univ. of Southern California, Los Angeles). Radiology; 96: 429-32(Aug 1970).

Total brain irradiation of primary malignant brain tumors can be an acceptable solution to the problem of accurately localizing the anatomic limits of these tumors. Careful attention to the inferior border of the treatment field is necessary to avoid excluding the anterior-inferior temporal lobe. Exclusion of this region can result in therapeutic failure. A treatment field that employs easily palpable landmarks and includes the entire brain is suggested. (auth)

41938 BRIEF CONTACT IRRADIATION OF MALIGNANT ENT TUMORS WITH ^{192}Ir. Koburg, E. Arch. Klin. Exp. Ohren-, Nasen- Kehlkopfheilk.; 191: 696-700(1968). (In German).

Iridium contact irradiation may, provided consideration is given to the dose, be combined with other forms of postirradiation, e.g. telecobalt irradiation. This applies even to carcinoma of the larynx in advanced stages. It is not yet possible to evaluate late radiation damage; since the energy spectrum is similar to that of radium, it may be expected that too large doses will lead to changes similar to those of radium overdosage. The results to date may be described as encouraging; brief iridium contact irradiation is a valuable additional method of treating malignant ENT tumors. (Excerpta Med.)

41939 SUPERVOLTAGE RADIOTHERAPY OF THE UROGENITAL SYSTEM WITH 43 MeV BETATRON: A STUDY OF 294 PATIENTS. Scherer, E.; Halama, J. (Ruhr Univ., Essen). Radiaz. Alta Energ.; 8: 89-98(Jul 1969). (In German).

Experience gained over the last few years with a 43 MeV betatron on a large number of patients shows that therapy using fast electrons and ultra-hard x rays in the field of high energies has considerable advantages. In connection with a series of tumors in the abdominal area, corresponding dose plans are presented. In the case of rather extended tumors of stage III the chances are now considerably better than they used to be. (auth)

41940 SUCCESSFUL TREATMENT OF ACROMEGALY: METABOLIC AND CLINICAL STUDIES IN 145 PATIENTS. Lawrence, John H.; Tobias, Cornelius A.; Linfoot, John A.; Born, James L.; Lyman, John T.; Chong, Claude Y.; Manougian, Edward; Wei, Wen C. (Univ. of California, Berkeley). J. Clin. Endocrinol. Metab.; 31: 180-98(Aug 1970).

The successful treatment of acromegaly, a disorder related to hyperfunction of the pituitary gland and first described in 1886 by Marie, has long been sought. The relative insensitivity of the pituitary gland to externally delivered radiation is well known, and the end results of treatment with conventional radiation have been relatively unsatisfactory — long periods of relief of signs and symptoms have not often been achieved and life expectancy has not been good. Surgical hypophysectomy, pituitary implants using ^{198}Au or ^{90}Y, and cryohypophysectomy have recently been used with considerable success. Thirteen yr ago, after more than 20 yr of radiobiologic research with heavy particles, high-energy protons were used and later the 910-MeV α-particle beam from a cyclotron to treat patients with acromegaly. One hundred twenty patients have been treated, and relief of symptoms and signs and a return to normal of elevated growth-hormone levels and other metabolic abnormalities have been achieved as measured by glucose tolerance and insulin tolerance. With reversal of the metabolic picture, it is reasonable to expect extension of life span. (auth)

41941 RESULTS OF LOCAL IRRADIATION OF INOPERABLE TUMORS OF THE DIENCEPHALON AND BASAL GANGLIA BY STEREOTAXIC IMPLANTATION OF ^{192}Ir. Mundinger, F.; Metzel, E. (Univ., Freiburg i. B.). Arch. Psychiat. Nervenkr.; 212: No. 1, 70-90(1968). (In German).

A new method is reported for the palliative treatment of inoperable diencephalic and basal ganglia tumors: the stereotaxic interstitial permanent implantation of iridium 192 for prolonged long-term irradiation. The location and size of the tumor are approximated with the help of ventriculoencephalotomographic, angiographic and γ encephalographic methods. After excision of small tissue particles with the implantation cannula which penetrates the tumor axially, the tumor is classified histologically and its size is determined. In spherical tumors the radioactive iridium 192 wires (0.3 mm in diameter and of variable length) are implanted in the center; in conical and cylindrical tumors the wires are implanted in the axis produced by the penetration of the tumor. The amount of activity to be implanted is calculated in such a way that 10,000 Rad are absorbed by the peripheral infiltrated tumor zone during a clinical accumulation period of 203 days (= the 2.7 fold of the half life). Seven cases (1 oligodendroglioma, 2 spongioblastomas, 4 astrocytomas), which were followed up for 26 months, illustrate the technical procedure and the palliative improvement. The neurological defects (epileptic attacks, pareses, disturbances of vision, extrapyramidal motor hyperkinesia) and mental disturbances (lack of conation, decrease of intellectual capacity, akinetic mutistic syndrome) almost completely disappeared in 4 cases corresponding to the accumulation of dosage. Other cases with a shorter follow-up showed improvement. In 2 cases (unilateral foramen of Monroe block, aqueduct block associated with hydrocephalus occlusus) the irradiation was successfully aided by the additional implantation of a Spitz Holter or Pudenz ventriculoauricular shunt in order to remove the increased intracranial pressure. (Excerpta Med.)

41942 APPLICATION OF EXTRACORPOREAL IRRADIATION OF THE BLOOD TO THE TREATMENT OF LEUKEMIA. Bullimore, J. A. (Cambridge Univ., Eng.). pp 138-9 of Progress in Lymphology. II. /Viamonte, Manuel (ed.). New York; Intercontinental Medical Book Corporation (1970).

From 2nd International Congress of Lymphology, Miami Beach, Fla. See CONF-680311.

It is difficult to draw firm conclusions from studying one patient, but it seems that extracorporeal irradiation of blood (ECI) produced the following effects in a patient with acute myelogenous leukemia. An immediate and marked reduction of circulating blast cell count, associated with an improvement in clinical condition. This response was much more rapid than that usually seen with chemotherapy. The urine was kept alkaline by administration of potassium citrate or sodium bicarbonate intravenously, and the serum uric acid did not rise significantly, nor did damage to kidneys from uric acid crystals occur. In spite of the very large doses of irradiation to the whole body, hemolysis was not marked. Finally, there were no untoward complications which were attributed to ECI. It was concluded that ECI may control symptoms and signs of acute leukemia for sufficient length of time to facilitate remission with chemotherapeutic agents. Perhaps it reduces total tumor mass, and acts in conjunction with chemotherapy to produce a remission. In some leukemias, perhaps of the lymphocytic type, it may prove effective, used alone. (auth)

41943 PRINCIPLES OF ENDOLYMPHATIC THERAPY WITH RADIOACTIVE SUBSTANCES. Weissleder, H.; Pfannenstiel, P.; Strickstrock, K.-H.; Hoffmann, G. (Univ., Freiburg i. B). pp 231-5 of Progress in Lymphology. II. /Viamonte, Manuel (ed.). New York; Intercontinental Medical Book Corporation (1970).

From 2nd International Congress of Lymphology, Miami Beach, Fla. See CONF-680311.

Endolymphatic radiotherapy with ^{131}I-labeled oily contrast media was evaluated for the treatment of lymph node malignancies. The possibility of lung injury following spillover of contrast media into the thoracic duct is considered. The radiation dose to the lungs was calculated for 17 patients following endolymphatic injection of 15 to 45 mCi ^{131}I-labeled oily contrast media. Patients that received radiation doses of up to 1500 Rads did not show any visible changes on chest radiograms. However, patients with marked lung fibrosis before treatment showed an adverse reaction to the additional load of radiation. (C.H.)

41944 LYMPHOKINETIC CONSIDERATIONS IN LYMPHOGRAPHY AND ENDOLYMPHATIC THERAPY. Koehler, P. R.; Potchen, E.; Cole, W. R.; Studer, R. (Washington Univ., St. Louis). pp 235-9 of Progress in Lymphology. II. /Viamonte, Manuel (ed.). New York; Intercontinental Medical Book Corporation (1970).

From 2nd International Congress of Lymphology, Miami Beach, Fla. See CONF-680311.

Thoracic duct bypass during the injection of ^{131}I-labeled oily contrast media for endolymphatic radiotherapy of lymph node neoplasms or lymphography reduced radiation doses to the lungs of rats. The ultimate radiation dose received by the peripheral lymph nodes was not significantly different following continuous or pulse type infusion. (C.H.)

41945 RADIOTHERAPY OF THE CANCERS OF THE ANTERIOR TWO-THIRDS OF THE TONGUE. POSSIBILITIES OF THE EMPLOY OF THE ELECTRONS OF HIGH ENERGY. Jucker, C.; Rovera, S.; Maestro, A.; Squassabia, A. (Univ., Pavia, Italy). Radiol. Med.; 56: 167-88(Feb 1970). (In Italian).

The following policy of management is currently used at the Department of Radiotherapy at Pavia University for radiotherapy of cancers of the anterior two-thirds of the tongue: for T1 and T2 lesions, interstitial gamma-ray therapy alone; for T3 lesions, external irradiation (25 MeV electron beam) followed by interstitial implantation; the combination of techniques is preferable to external irradiation alone, in view of lower incidence of radiation necrosis of the mandible; for T4 lesions, external irradiation alone, for palliative purposes. The early results appear promising. The behaviour of the 25 MeV electron beam beyond the mandible in a phantom is presented. (auth)

41946 PERITONEAL FLUID CELLULAR PATTERNS IN OBSTETRICS AND GYNECOLOGY. McGowan, Larry; Davis, Robert H. (Hahnemann Medical Coll. and Hospital, Philadelphia). Amer. J. Obstet. Gynecol.; 106: 979-95(1 Apr 1970).

Cytologic specimens were obtained by culdocentesis in women and by abdominal aspiration in mice. All specimens were processed by Papanicolaou's technique and subjected to cytodifferential and morphologic examination. The mouse represents a suitable experimental model for the study of peritoneal fluid cells. We believe cellular patterns of peritoneal fluid can aid in the diagnosis of human ovulation, fetal sex, uterine myomas, pelvic inflammatory disease, and intra-abdominal lymphatic obstruction due to cancer. In addition, cellular patterns during radiation therapy for cervical cancer and therapy for pelvic inflammatory disease provide a notable advance in evaluating treatment. Our work offers new opportunities for future studies in obstetrics and gynecology. (auth)

Blast and Thermal Effects

Refer also to abstracts 41548, 41549, and 41867.

41947 AFTER A NUCLEAR EXPLOSION. Gorelov, L. Sov. Krasnyi Krest; No. 10, 18-21(1969). (In Russian).

The different types of radiation produced by a nuclear explosion, the external and internal effects of exposure, and time- and dose-relationships are discussed in simple terms. Differences between chronic and acute radiation sickness, stages of radiation sickness, degrees of severity and symptoms are also explained. Various agents available for preventing or mitigating the effects of radiation sickness (activated charcoal, barium sulfide, potassium iodide) and for treating it in different stages (drugs to normalize CNS function, to detoxify and desensitize, to combat hematopoietic disorders and, where indicated, preparations to control infections and hormones to promote adrenal function) are listed. Practical suggestions regarding bedrest, hygiene, and nutrition for persons exposed to moderate to heavy doses of radiation are also given. (JPRS)

Radiation Effects on Animals

41948 (ANL-7635) BIOLOGICAL AND MEDICAL RESEARCH DIVISION ANNUAL REPORT, 1969. (Argonne National Lab., Ill.). Dec 1969. Contract W-31-109-eng-38. 342p. Dep. CFSTI.

Separate abstracts were prepared for eleven sections of the report. Additional sections are included on laboratory animal medicine, the JANUS facility, and mammalian genetics. (H.L.W.)

For abstracts of individual sections see: 41719, 41720, 41733, 41734, 41796, 41877, 41892, 41949, 41956, 42025, and 42026.

41949 (ANL-7635, pp 229-91) BIOPHYSICS. (Argonne National Lab., Ill.).

The cell cycle distribution of hamster cells in stationary phase cultures was investigated. A plot of cumulative mitotic index versus time was obtained which, in addition to a plot of cells labeled with $^{3}HTdR$ as a function of time, allowed the distribution of the population within the cell cycle compartments and the length of the cell cycle when growth resumed to be determined. Hamster cells in S phase were x-irradiated with two doses of 1800 R in the presence of cysteamine with different intervals between the doses. The results are compared with results of exposure to single doses of 1800 and 3600 R in the presence of cysteamine. Marked recovery occurred in cells irradiated with two doses with an interval between. Hamster cells in G_1 were exposed to hydroxyurea at varying periods and cysteamine was added just prior to x irradiation. It was found that cysteamine protected cells sensitized by hydroxyurea more than resistant cells. Protective effects of AET, cysteamine, and thiophosphates on x-irradiated hamster cells were examined. Sensitization properties of N-ethylmaleimide and iodoacetic acid were determined by adding them to cultures of hamster cells during x-irradiation. X-radioinduced division delay in synchronized hamster cells was compared with delay induced by cycloheximide. The effects of x radiation on the uptake of tritium-labeled leucine in synchronized hamster cells were studied and the significance of the results with regard to protein synthesis is discussed. Studies on uv-radioinduced division delay in synchronized cells showed that the delay was much larger in magnitude than that following x-ray doses that reduced the cells to the same survival, but, as in the case of x rays, division delay was age dependent and the largest delays occurred when cells were irradiated in S. Other studies on hamster cells included effects of interaction of x rays and ultraviolet light, radioinduced chromosome aberrations in cells treated with cysteamine, and polyploidy induced by x rays during the generation cycle of synchronized cells. Studies on interactions of nucleic acid derivatives included conformational properties of ribose hydroxyl protons. Theoretical calculations of nucleic acid conformations were carried out and results are presented for cytidine and adenosine. Molecular interactions of biologically active molecules of mononucleosides, nucleotides, and dinucleotides were studied. Magnetic resonance studies were conducted on γ-irradiated dinucleotides and on actinomycin D. Investigations on Escherichia coli included mutagenesis by ultraviolet and visible light in continuous cultures; growth and mutagenesis in the Nephelostat; effects of ultraviolet and visible light on a multiple repair-deficient strain; lethal effects of long wavelength ultraviolet and visible light; a sequential repair model of photoreactivation; and lethal effects of ultraviolet using a high intensity vapor arc lamp. Studies on the protein, Concanavalin A, included x-ray crystallographic determination of structure, chemical study of binding sites, and chemical and enzymatic cleavage. A new procedure to compare amino acid sequences of Bence-Jones and

other proteins is described and the crystallography of the Mcg L-type Bence-Jones protein was investigated. A crystallographic study of the Mcg Myeloma protein was carried out. Methods for predicting helical segments in glucagon are described. Studies on amino acid sequencing of hemoglobin from the fish, Catostomus clarki, showed that polymorphisms resulted from different α and β chain combinations. Seeds of barley were exposed to γ and neutron radiation for studies on effects of radiation on growth of coleoptiles and leaves. (H.L.W.)

41950 STUDY OF THE MACROMOLECULAR METABOLISM OF CHICK EMBRYO SKIN IN ORGAN CULTURE. EFFECT OF IONIZING RADIATIONS. Kong, Y. C.; Reyss-Brion, M.; Kirrmann, J. M. (College de France, Paris). Arch. Sci. Physiol.; 23: 391-400(1969). (In French).

The metabolic processes involved during the differentiation of feather-producing cells was studied in chick embryo skin. Fragments of the skin were cultured in the presence of radioactive precursors. The explants were x-irradiated to inhibit differentiation and the radioactivity in the explants was later determined by autoradiographs or by use of a scintillation counter. It was shown that thymidine accumulated in the feather germ cells, but this localization was inhibited by irradiation. Leucine and uridine were incorporated equally in the dermis and epidermis; the incorporation was not affected by irradiation. To detect the beginning of feather germ formation, explant cultures were irradiated on the 6th, 7th, and 8th day of incubation and a rapid increase of DNA formation was found starting on the 7th day. (F.M.M.)

41951 PRELIMINARY STUDY OF THE EFFECTS OF UNIFORM MAGNETIC FIELD ON THE BLOOD. Bresson, Y.; Bellossi, A. (Laboratoire de Biophysique, Dakar, Senegal). Bull. Soc. Med. Afr. Noire Langue Fr.; 14: 612-14(1969). (In French).

Biological effects of magnetic fields on blood are investigated. Effects of a uniform magnetic field on blood that is a tissue rich in iron are emphasized. Results are presented in this preliminary study. (auth)

41952 EFFECTS OF IRRADIATION ON SUB-CELLULAR COMPONENTS. II. HYDROXYLATION IN THE MICROSOMAL FRACTION. Wills, E. D.; Wilkinson, A. E. (St. Bartholomew's Hospital, London). Int. J. Radiat. Biol.; 17: 229-36(1970).

The oxidative demethylation of aminopyrine and of p-chloromethylaniline or the hydroxylation of aniline by suspensions of rat-liver microsomes is inhibited after irradiation with doses of electrons or γ-rays in vitro within the range 5 to 100 kRads. There is little fall in activity immediately after irradiation, but after incubation of the microsome suspensions at 4, 20 and 37°C. substantial decreases in the rates result. The decrease of capacity to demethylate or hydroxylate oxidatively is accompanied by an increase in the lipid peroxide content of the microsomal suspensions. It is considered that peroxidation induced by irradiation causes disintegration of the lipid membranes essential for the integrity of the electron transport system responsible for this oxidative metabolism. (auth) (UK)

41953 ON THE RELATIVE IMPORTANCE OF REPAIR AND PROGRESSION IN ELKIND RECOVERY AS MEASURED IN SYNCHRONOUS HeLa CELLS. Lange, C. S. (Christie Hospital, Manchester, Eng.). Int. J. Radiat. Biol.; 17: 61-79(1970).

A method is described for the estimation of a quantity which can be considered to be the potential ability to repair sub-lethal damage, or its equivalent, the amount of sub-lethal damage induced. This method was applied to populations of HeLa cells synchronized by mitotic harvest. The sensitivity (with respect to loss of reproductive integrity) of HeLa cells to single radiation doses and the ability to repair significant amounts of sub-lethal damage were found to be dependent on cell-cycle position. The more resistant phases were found to be associated with a greater potential for repair of sub-lethal damage. Significant repair was found to be possible only during early and mid G_1 and in late S. The proportion of sub-lethal damage actually repaired was dependent on the fractionation interval. 4 to 8 h ($\frac{1}{6}$–$\frac{1}{3}$ of cell cycle) allowed only partial repair; 18 h ($\frac{3}{4}$ of cell cycle) sufficed for full repair. 20 to 25°C incubation was found to permit progression from M into early G_1, but to inhibit totally the repair of sub-lethal damage. Since the amount of sub-lethal damage induced is equivalent to the potential ability to repair sub-lethal damage, it was possible to show that the sub-lethal damage is induced only at certain specific parts of the cell cycle. (auth) (UK)

Invertebrates

Refer also to abstracts 41754, 41755, 41801, 41860, 41892, and 42047.

41954 LASER-INDUCED CHANGES IN DNA SYNTHESIS AND EMBRYONIC DEVELOPMENT IN SEA URCHINS. Paul, J. S.; Zuzolo, R. C.; Fong, B. A.; Kopac, M. J. (New York Univ., N. Y.). Exp. Cell Res.; 60: 166-74(May 1970).

Arbacia punctulata eggs were irradiated with low-level laser energy (3.2 millijoules (mJ)/cm² for 500 μsec) before fertilization. The zygotes and early embryos were observed in order to detect developmental changes and alterations in DNA synthesis. No microscopic changes occurred in the eggs after irradiation, but many developmental abnormalities, similar to those produced by cytotoxic or metabolic agents, appeared after fertilization. A moderate degree of asynchrony was also detected in irradiated populations. Synthesis of DNA (S phase) was determined by using tritiated thymidine and scintillation counting techniques. The low-level laser irradiation produced a pronounced delay in post-fertilization DNA synthesis. The onset of the first synthetic period was delayed approximately twice as long as the control. The delay continued throughout four synthetic periods, finally (at 140 min), resulting in a delay of one synthetic period behind the controls. The duration of these synthetic periods was variable and always longer than the controls. (auth)

41955 DIFFERENTIATION OF THE IMAGINAL MUSCLES IN X-IRRADIATED HOUSE FLY PUPAE. Sivasubramanian, P.; Bhaskaran, G.; Nair, K. K. (Bhabha Atomic Research Centre, Trombay, India. Simon Fraser Univ., Burnaby, British Columbia). Ann. Entomol. Soc. Amer.; 63: 1019-22(Jul 1970).

X irradiation of pupa of Musca domestica nebulo (F.) (Diptera: Muscidae), less than 20 hr after puparium formation induces drastic dystrophic changes in the structure of tubular as well as fibrillar muscles. There is considerable reduction in the number of nuclei, with evident hypertrophy and disturbance in their orderly arrangement within the fibers. The differentiating fibers tend to fuse with one another and, in extreme cases, the integrity of the individual fibers is lost. With increase in age of the pupa at the time of irradiation the extent of radiation damage in the imaginal muscles is progressively less. (auth)

Vertebrates

Refer also to abstracts 41720, 41733, 41769, 41771, 41772, 41775, 41777, 41778, 41781–41783, 41907, 41908, 41911, and 41912.

41956 (ANL-7635, pp 1-54) GENERAL RADIATION BIOLOGY. (Argonne National Lab., Ill.).

Four strains of mice were used in studies on chronic γ radiation lethality. Doses of 0 to 56 R/day were administered for the duration of life and survival data are presented in the form of tables and graphs. A survey was made of tumors of reticular tissue, ovarian tumors and cysts, pulmonary tumors, hepatomas, total tumor incidence, and renal lesions. Studies on long-term effects of low doses of neutrons on immune responses of mice showed that the number of plaque-forming cells per spleen reached a higher peak in males than in females. Tritium-labeled thymidine was applied topically and injected intraperitoneally for studies on cell kinetics of the corneal epithelium. Results suggested that topical application could provide a satisfactory pulse labeling method for studying cell kinetics in the cornea and that the estimate of the duration of DNA synthesis with intraperitoneal injection was an overestimate caused by the duration of pulse of labeling. Studies on factors influencing the uptake of tritiated thymidine led to the following conclusions: the uptake of ^{3}HTdR by crypt cells of the jejunum is greater when this label is given intraperitoneally than intravenously; the duration of availability may be longer when ^{3}HTdR is given intraperitoneally; when ^{3}HTdR was given intravenously there was no difference in the total radioactivity in the gut or eye of groups of mice injected at 1200 and 2400 hr; in the Mastomys rat the uptake of ^{3}HTdR following intraperitoneal injection is even more variable than in the mouse. Effects of x radiation on saccharin aversion were studied in normal mice and in mice with low blood and tissue catalase; results indicated that the aversive stimulus was a product of the peroxidatic action of catalase. Evidence of a catalytically inactive catalase-anticatalase was obtained by immunizing normal mice with blood of catalase-mutant mice. Organ weights and catalase activities were determined in wild ducks and the domestic chicken; a correlation was found between catalase levels and x-ray resistance. Of eight flavoprotein enzymes studied in the liver and kidney of mice following whole-body x radiation, only three were affected by radiation. The D-amino acid oxidase of kidney exhibited increased activity at most times after most doses. The L-α-hydroxy acid oxidase of kidney also showed increased activity. Monoamine oxidase activity in the liver showed increases early after 50 R and decreases were seen later after all doses. Three-dimensional replicas obtained

by the freeze-etch technique provided information about the fine structure of small blood vessels and loose connective tissue of the mesentery of the young chick. Studies on x irradiation of chick embryos showed that soybean trypsin inhibitor protected the microvasculature against radiation injury. Studies were conducted on effects of split exposures on resistance to early circulatory death in γ irradiated chickens. X irradiation of explanted 3-day chick embryos caused increased vascular permeability and degenerative changes of vessel walls. Ground squirrels were γ irradiated during arousal from hibernation and effects on intestinal crypt cells were studied. In vitro studies on kinetics of the immune response included effects of hydroxyurea on DNA synthesis in plaque-forming cells. Data on immunization before x irradiation suggested that the immunologically competent initial cells may be more easily stimulated and may recover from injury more easily than the activated memory cells which are present at the time of reinjecting sheep red blood cells because of prior initial antigenic stimulation. Studies on effects of x radiation on eggs of Tribolium castaneum showed that hatching delay was directly proportional to radiation dose. Studies on effects of x radiation on developing Tribolium castaneum included effects on body weight, elytrum weight, and mechanical strength of elytra. Lethal effects of monoenergetic neutrons and ^{60}Co γ rays on Tribolium castaneum were investigated. Studies were conducted on the development of the mid-gut of Tribolium and it was found that x radiation during the larval stage caused some damage to the development of the adult mid-gut. (H.L.W.)

41957 (BRH/DBE-70-1) RADIATION BIO-EFFECTS. Summary Report, January-December 1969. Hodge, Donald M. (comp. and ed.) (Public Health Service, Rockville, Md.). 229p. Dep. CFSTI.

Separate abstracts were prepared for twelve sections of the report. An additional section on the animal care unit is included and a list of publications for the period January to December, 1969, is appended. (H.L.W.)

For abstracts of individual sections see: 41735, 41797, 41798, 41878, 41879, 41958–41961, 41993, 41994, and 43871.

41958 (BRH/DBE-70-1, pp 59-82) PATHOLOGIC STUDIES SECTION. (Public Health Service, Rockville, Md.).

The Pathologic Section conducted research on the following projects: prolongation of life in a microwave field by means of an environmental chamber; in vivo and in vitro development of rat mammary tumor cells from x-radioinduced cystadenoma; effects of whole-body x radiation and exposure to externalized mammary tissue on rat mammary carcinogenesis; the effect of drugs and radiation on the incidence of mammary tumors in rats; host cell reactivation of uv-irradiated virus by mammalian cells; thyroid age sensitivity in rats; spontaneous lymphosarcoma in a colony of rats; radiation-aflatoxin carcinogenesis; effects of age on radiation mortality in the hamster; cataracts induced by 30 KVP and 250 KVP x rays; and effects of x radiation on sarcoma forming ability and virus induction in BALB/3T3 cells. (H.L.W.)

41959 (BRH/DBE-70-1, pp 83-94) NEUROPHYSIOLOGIC STUDIES SECTION. (Public Health Service, Rockville, Md.).

The Neurophysiologic Studies section examined effects of microwave radiation on the central nervous system. Monkeys were used for experiments on cerebral effects of radio frequency energy. Power levels ranging from 10 to 20 mW were recorded from the right or left parietal lobe during controlled exposures of the living macaque rhesus head in a resonant cavity with an average power of less than 30 W delivered in the field. The cerebral power levels varied in accordance with the head position in the field. The findings suggested that orientations of persons exposed in radio frequency fields might influence the power to which the brain was exposed and thus the nature of effects on cerebral activity during and after exposure. The findings were dependent on the characteristics of the cavity, with particular relationship to operating frequency, resonance, load characteristics, and load measurement techniques. Geometric relationships of head holder to the field were considered significant, as were ambient humidity and temperature. (H.L.W.)

41960 (BRH/DBE-70-1, pp 95-151) METABOLIC STUDIES SECTION. (Public Health Service, Rockville, Md.).

The Metabolic Studies section conducted research on effects of 2450 MHz microwaves on human immunoglobulin G; biological and physico-chemical properties of 2450 MHz microwave irradiated human immunoglobulin G; thermal inactivation of ribonuclease; effects of in utero x radiation on the peripheral blood of the neonatal rat; hematological and erythropoietic responses in x-irradiated fetal rats; effects of pretreatment with endotoxin on hematological and erythropoietic response in x-irradiated fetal rats; comparative response to 30 kVp and 250 kVp x rays of the mouse hematological system; impaired incorporation of labeled phenylalanine into protein in the x-irradiated fetal rat; persistence of depressed incorporation of labeled phenylalanine into fetal rat protein after in utero x irradiation; and effects of x radiation on precursor amino acid pools, labeled amino acid incorporation into proteins, and protein synthesis in fetal rats. (H.L.W.)

41961 (BRH/DBE-70-1, pp 205-13) COLLABORATIVE RADIOLOGICAL HEALTH LABORATORY. (Public Health Service, Rockville, Md.).

The Collaborative Radiological Health Laboratory was established for conducting research on long-term effects of a single exposure of low level γ radiation on the beagle with emphasis on radiosensitivity of the unborn and young animal. The prenatal response of beagles to irradiation during the preimplantation embryonic, and early fetal periods was studied. Exposure to 150 R γ radiation during the second half of the preimplantation period had no significant effect on prenatal mortality or on the incidence of developmental malformations. However, a marked increase in prenatal mortality occurred when the same exposure was received shortly after implantation during early organogenesis. (H.L.W.)

41962 GALACTOSE CATARACT OF YOUNG RATS FOLLOWING WHOLE-BODY IRRADIATION. Hockwin, O.; Bergeder, H. D.; Kaiser, L. (Univ., Bonn). Ber. Deut. Ophthalmol. Ges.; 68: 135-9(1968). (In German).

Rats received 440 R whole-body x radiation. At various times after exposure they were given a diet containing galactose. X radiation alone did not produce cataracts. X radiation in combination with galactose diet produced cataracts that were measured with a slit lamp. The latent period between x irradiation and appearance of cataracts was analyzed as to dependency on age of animal and start of galactose feeding. (H.B.G.)

41963 EFFECTS OF GAMMA AND X IRRADIATION ON THE VARIETY NORMAL AND ALBINO OF BIOMPHALARIA GLABRATA, SAY (GASTROPODA, PROSOBRANCHIATA). Ravera, O.; De Bernardi, R. (EURATOM, Ispra, Italy). pp 1137-50 of Symposium International de Radioecologie. Vol. II. Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique (1970). From Conference on Radioecology, Cadarache, France. See CONF-690918-(Vol.2).

The radiosensitivity of Biomphalaria glabrata, an intermediate host of Schistosoma, was studied by determining the mortality, fecundity and fertility of the adult and the viability of the eggs in two varieties (normal and albino). Adult mortality increased with dose and was higher in the albino variety. For the embryo significant differences were observed for different doses and stages but no difference was noted among varieties and type of radiation (x and γ rays). (auth) (France)

41964 MICROVESICULATION, VACUOLIZATION, AND VESICLE FORMATION IN CAPILLARY ENDOTHELIUM IN NORMAL AND IRRADIATED ANIMALS. Alekseev, O. V.; Chernukh, A. M. (Inst. of Normal and Pathological Physiology, Moscow). Arkh. Anat., Gistol. Embriol.; 56: 110-15(Mar 1969). (In Russian).

Electron microscopy showed that in the endothelium of the blood capillaries in the lungs of normal albino mice there were always present only microvesicles; vacuoles were seldom encountered, while vesicles were extremely rare. Within three hours after total x irradiation (600 R) the number of microvesicles, vacuoles, and vesicles in the endothelium was considerably increased. One hour after intravenous administration of India ink, its particles were electron-microscopically found only in the lumina of the capillaries, both in the control and irradiated animals; they were not found in the vesicular structures. Both in normal and under conditions of an early irradiation pathology, the vacuoles might appear either during formation of microvesicles, or fusion of the latter. Normally, the endothelial vesicles are principally formed due to microvesiculation and vacuolization, while under conditions of irradiation causes and mechanisms of vesicle-formation might be numerous. The five most probable mechanisms of vesicle formation in the capillary endothelium under conditions of irradiation pathology were stated. On the basis of the data on ultrastructural mechanisms of microvesiculation, vacuolization, and vesicle-formation obtained in pathological and normal states, the dual (protective and pathogenic) role they play in pathology of the endothelium and in impairment of vascular permeability is discussed. (auth)

41965 EXPERIMENTAL STUDIES ON THE INCORPORATION OF ^{32}P AND ^{35}S IN THE GENITAL ORGANS OF THE RAT AND ITS DEPENDENCE ON SHORT WAVE IRRADIATION. Hofmann, D.; Menkhaus, G. (Westfaelische Wilhelms-Univ., Muenster,

Ger.). Zentralbl. Gynaekol.; 91: 593-607(10 May 1969). (In German).

To measure blood flow and permeability, female rats were injected subcutaneously with 33 μCi/g of ^{35}S and 0.5 μCi/g ^{32}P. Thereafter, they received microwave radiation for 5 min. At various time intervals after treatment, the animals were sacrificed and the genital organs analyzed for ^{32}P and ^{35}S content. Microwave irradiation caused increased blood flow in the uterus and decreased blood flow in the placenta with increased ^{35}S incorporation into the fetus. It was concluded that the teratogenic damage of microwave radiation in early pregnancy is a consequence of changes in blood flow and permeability, especially in uterus and placenta. (H.B.G.)

41966 EARLY VASCULAR INJURY IN THE X-IRRADIATED CHICK EMBRYO: AN ELECTRON-MICROSCOPE STUDY. Stearner, S. Phyllis; Sanderson, Margaret H. (Argonne National Lab., Ill.). J. Pathol.; 99: 213-18(1969).

Ultrastructural changes associated with early vascular injury after lethal x-irradiation in the 3-day chick embryo include severe and extensive damage to the endothelium and the mesenchymal cells surrounding the vessels. Cellular damage can be correlated with changes in vascular permeability and with circulatory degeneration and stasis observed in vivo in the initial radiation response. Increased pinocytic activity may lead to intracellular and intercellular edema, and frank destruction of the endothelial barrier can account for the loss of large amounts of whole plasma as well as plasma proteins into the extravascular spaces. Endothelial junctions appear unaltered, even in badly damaged vessels. Circulating cells adhere to the endothelial cell membrane and probably serve as sites of thrombus formation. Stasis in damaged vessels results from decreased plasma volume and localised formation of thrombi. Complete occlusion, degeneration and lysis follow rapidly. There are few alterations in many vessels, although severe damage is present in others. These findings support the suggestion that direct vascular injury is of major significance in the development of the circulatory collapse that follows lethal irradiation. (auth)

41967 COMPARATIVE STUDY OF NUCLEAR EXPULSION FROM THE LATE ERYTHROBLAST AND CYTOKINESIS. Skutelsky, E.; Danon, D. (Weizmann Inst. of Science, Rehovot, Israel). Exp. Cell Res.; 60: 427-36(Jun 1970).

Electron and light microscopical analysis of rabbit bone marrow and erythroid spleen clones from lethally irradiated mice injected with syngeneic bone marrow revealed marked similarities between the process of nuclear expulsion from the late erythroblast and mammalian cytokinesis. Polysome disaggregation previously noticed in tissue culture cells in metaphase was found also to exist in erythroblasts in mitosis as well as in the late stages of nuclear expulsion. In both systems erythroblasts in mitosis and in the nuclear expulsion process, a reduction in the capacity to incorporate amino acids was demonstrated by autoradiography. Analysis of the erythroid cell populations of spleen clones in mice treated with actinomycin D indicates that inhibition of RNA synthesis does not inhibit nuclear expulsion. The appearance and location of centrioles in late erythroblasts prior and during nuclear expulsion indicates that, as in cytokinesis, they may play a role in the expulsion. Deformations appearing in late erythroblast nuclei and cytoplasm after treatment in vivo with Colcemid support this hypothesis. (auth)

41968 SOME RADIOBIOLOGIC ASPECTS OF THE IONIZING RADIATION EFFECT ON FETUS DEVELOPMENT. Mularek, Olga. Patol. Pol.; 21: 45-54(Jan-Mar 1970). (In Polish).

Female rats were irradiated once with x rays at a dose of 250 R after 6½, 9½, and 18½ days of pregnancy. Some of the animals irradiated after 9½ days received doses of 150 R. The first day of pregnancy was determined on the basis of finding spermatozoa in vaginal smears. The most significant effects were high percentages of intrauterine absorption and fetal mortality, and severe congenital cerebral anomalies in the brain of animals irradiated after 9½ days of fetal life, a critical period in the development of rats. Ionizing radiation produced changes in neonates also when applied in the period preceding organogenesis; no period in development is entirely insensitive to the action of x rays. (auth)

41969 INTERACTION BETWEEN TISSUES AND ACTIVE DYE AT DIFFERENT STAGES OF ACUTE RADIATION INJURY. Dolgov, E. G. (Semipalatinsk Medical Inst., USSR). Byull. Eksp. Biol. Med.; 69: No. 5, 39-42(May 1970). (In Russian).

A study was made of the interaction between internal organs (liver, kidney, small intestine, spleen, brain, adrenal gland) of albino rats and active dye, procion bright red, following 6 hours, 1, 3, 5, 7, and 10 days after single whole-body x-irradiation with a dose of 800 R. The irradiation resulted in increasing the dye sorption by the majority of the tissues examined, the sorption being characterized mainly by covalent bonds. Disturbances in the tissue sorption were observed for the space of the entire post-irradiation period. An increase of the active dye sorption is most pronounced in tissues of the small intestine and spleen. The changes discovered may be due to some serious structural reorganization of cytoplasmic protein complexes effected by ionizing radiation. (auth)

41970 EMBRYONIC MOTILITY AND POSTHATCHING PERCEPTION IN BIRDS AFTER PRENATAL GAMMA IRRADIATION. Oppenheim, Ronald W.; Jones, James R.; Gottlieb, Gilbert (North Carolina Dept. of Mental Health, Raleigh). J. Comp. Physiol. Psychol.; 71: No. 1, 6-21(1970).

An attempt was made to destroy selectively parts of the avian embryonic nervous system by ionizing radiation and to evaluate the possible behavioral effects of this destruction. Accordingly, duck and chick embryos were irradiated at different stages of development with varying doses of γ rays (200, 400, 700, and 1,000 R). Subsequently, embryonic behavior, hatching behavior, posthatching approach behavior, and posthatching color preferences were evaluated. Except for a reliable difference in time of hatching (irradiated embryos hatched 6 to 8 hr. later than controls), there were no consistent differences between irradiated and control embryos on any of the measures. Furthermore, counts of sensory and motor cells in the spinal cord also revealed no differences between control and irradiated embryos. These results indicate that the nervous system of bird embryos is less susceptible to ionizing radiation than the developing mammalian nervous system. (auth)

41971 DEFINITION OF THYMIC-DEPENDENT AREAS IN THE PERIPHERAL LYMPHOID TISSUES OF RABBITS. Sutherland, D. E. R.; McKneally, M. F.; Kellum, M. J.; Good, R. A. (Univ. of Minnesota, Minneapolis). Int. Arch. Allergy Appl. Immunol.; 38: 6-36(1970).

The recovery of small lymphocytes in the periarteriolar region of the spleen, in the perifollicular and deep cortical regions of the lymph node and in the midzone of the rabbit appendix is profoundly retarded after x irradiation when the thymus is lacking. These areas of the rabbit lymphoid tissues contain a distinct population of small lymphocytes that may be termed thymic-dependent cells. Prolonged reduction of the number of small lymphocytes in these areas is associated with wasting, germinal center hyperplasia, plasmacytosis, amyloidosis and an increased incidence of positive Coombs' tests. When the results of thymectomy are contrasted with those involving extirpation of the gut associated lymphoepithelial tissue in the rabbit, a firm experimental basis is provided for the concept of two separate functional units within the mammalian lymphoid system. (auth)

41972 BEHAVIORAL EFFECTS OF NEONATAL IRRADIATION OF THE CEREBELLUM. II. QUANTITATIVE STUDIES IN YOUNG-ADULT AND ADULT RATS. Wallace, Robert B.; Altman, Joseph (Univ. of Hartford, Conn. Purdue Univ., Lafayette, Ind.). Develop. Psychobiol.; 2: 266-72(Mar 1970).

Young-adult and adult rats whose cerebellum was focally irradiated with a variable number of daily doses of 200 R x ray during infancy were tested for spontaneous locomotion, in activity wheels, for muscular strength, in a weight-pulling apparatus, and, for skill in coordination, in a rope-climbing apparatus. Spontaneous activity declined as a function of number of daily irradiations; the interaction of treatment, age, and prior experience was also investigated. Weight pulling capacity, as determined by running time in an alleyway, was not affected by irradiation with 1 to 4 × 200 R with loads equalling the rats' own body weights. Ease of rope climbing was inversely related to the number of daily irradiations in terms of climbing time, number of shocks received, falls off the rope, and other criteria. (auth)

41973 BEHAVIORAL EFFECTS OF NEONATAL IRRADIATION OF THE CEREBELLUM. I. QUALITATIVE OBSERVATIONS IN INFANT AND ADOLESCENT RATS. Wallace, Robert B.; Altman, Joseph (Univ. of Hartford, Conn. Purdue Univ., Lafayette, Ind.). Develop. Psychobiol.; 2: 257-65(Mar 1970).

The cerebellum of rats was x-irradiated from birth with daily doses of 200 R for 1, 2, 3, 4, 5, 8, and 10 days. The animals were killed at fixed periods after irradiation and at various ages for histological evaluation of the cerebellum or they were permitted to survive for a prolonged period for behavioral testing. Gross measurement indicated that anteroposterior growth of the cerebellum was retarded as a function of the number of doses delivered except in animals that received a single dose of 200 R. A number of pre- and post-weaning qualitative behavioral observations (tremor, ataxia, level of activity) correlated with the retardation of cerebellar development produced by the ir-

radiation schedules, though some behavioral recovery was noted in the older animals. (auth)

41974 DO CELLS OUTSIDE THE TESTES PARTICIPATE IN REPOPULATING THE GERMINAL EPITHELIUM AFTER IRRADIATION. NEGATIVE RESULTS. Green, E. L.; Bernstein, S. E. (Jackson Lab., Bar Harbor, Me.). Int. J. Radiat. Biol.; 17: 87-92(1970).

It is possible that after irradiation, cells from elsewhere in the body invade the testes and repopulate the germinal epithelium. This possibility has been tested with parabiosis and bone marrow experiments. One member of a surgically united pair of male mice received 900 R of whole-body x irradiation and the donor member received 900 R of testicular irradiation with the rest of his body shielded under lead. Twenty one days after exposure, the mice were separated, wounds allowed to heal, and afterwards mated. In the marrow inoculation experiments, irradiated and unirradiated bone-marrow cells were injected into irradiated male recipients. Whole-body irradiation of donors and recipients was at 25 OR and 45 OR and the time of inoculation after irradiation varied between 4 and 120 hr. Indications were that haematopoietic cells immigrated from donor to test mouse in the parabiotic pairs, because the test mice survived exposure to 900 R whole-body x irradiation. The breeding results gave no evidence that precursors of germ cells immigrated from one mouse to the other. Similarly the irradiated male mice inoculated with bone-marrow cells gave no evidence that their germinal epithelium had been repopulated by cells from the donor males. (UK)

41975 FORMATION AND DISTRIBUTION OF LYSOSOMES AND OTHER RESPONSES OF SARCOMA-180 MOUSE ASCITES TUMOR CELLS TO X IRRADIATION. Leeper, Dennis Burton. Iowa City, Iowa; Univ. of Iowa (1969). 138p.

Thesis.

The dose dependence and time course of lysomes formation following x irradiation was studied in the S-180 mouse ascites tumor. Tumor cells in the exponential phase of growth were irradiated in vivo with exposures between 300 and 5000 R. Fifty million irradiated cells were then inoculated into unirradiated hosts. During the following 100 hr, the cells were cytochemically examined with the light microscope for acid phosphatase activity (Gomori method). Cells were scored for the presence of acid phosphatase activity (lysosomes) and were also classified on the basis of the distribution of the lead sulfide granules in the cytoplasm. Other parameters measured after irradiation were mitotic index, viability index, abnormal anaphases and telophases, tumor growth (weight change of inoculated animals), and ultimate survival (tumor takes). In exponentially proliferating ascites tumors, about 12% of the cells demonstrated acid phosphatase activity with this method. The frequency of cells demonstrating acid phosphatase activity increased after irradiation, passed through a maximum at about 30 hr postirradiation (P.I.), and then declined to a plateau whose height was exposure dependent. The fraction of unaffected cells at 30 hr P.I. declined exponentially as a function of exposure with a D_0 of 2.25 kR. The D_0 was increased 1.7 times by the presence of 160 mg/kg of β-mercaptoethylamine during irradiation. Acid phosphatase activity was first detected in the Golgi region of the cell. This was followed by appearance of lead sulfide granules throughout the cytoplasm. Dispersion proceeded more rapidly with higher exposures. By 100 hr after 3.0 kR, 100% of the cells demonstrating acid phosphatase activity had granules distributed throughout the cytoplasm; after 5.0 kR, 100% was reached by 60 hr P.I. The presence of β-mercaptoethylamine during irradiation decreased the migration rate by a factor of 1.5. Electron microscopy showed that the lead deposited during the cytochemical reaction for acid phosphatase was associated with vacuoles corresponding to morphologic lysosomes. The 100% tumoricidal dose (6.0 kR) corresponded to the one that resulted in nearly 100% of the tumor cells developing lysosomes. Although none of the other parameters measured varied directly with lysosome formation, the addition of the chemical protector reduced the efficacy of the irradiation by a similar factor in all cases. The frequency of cells containing lysosomes decreased both by diminished acid phosphatase activity in cells and by dilution from repopulation with less damaged tumor cells. Lysosomes probably contribute to the recovery process by the segregation and inactivation of aberrant cytoplasmic components that result from radiation damage to nuclear structures. The role of lysosomal hydrolases in radiation damage and their relation to tumor therapy is discussed. (Diss. Abstr.)

41976 LYMPHOSARCOMA ASSOCIATED WITH NODAL CONCENTRATION OF PLUTONIUM IN DOGS: A PRELIMINARY REPORT. Lebel, J. L.; Bull, E. H.; Johnson, L. J.; Watters, R. L. (Colorado State Univ., Fort Collins). Contract AT(11-1)-1787. Amer. J. Vet. Res.; 31: 1513-16(Aug 1970).

Translocation, retention, and excretion of plutonium (PuO_2) from contaminated puncture wounds were studied in 40 young adult, male Beagle dogs. One-half of the 40 dogs were given chelation therapy. The dogs were serially killed at intervals up to 1 yr after PuO_2 injections. One of the contaminated Beagles not treated with penthanil died of generalized lymphosarcoma 4 months after contamination. Sections of kidneys, liver, spleen, and prescapular lymph nodes were shown to contain various concentrations of plutonium (Pu) by autoradiography (α), with the left prescapular lymph node having the greatest concentration. At necropsy, several other dogs had enlarged lymph nodes. Results of histopathologic studies indicated that hyperplasia rather than neoplasia was responsible for the enlargement. Our findings indicate that the lymphatic system is an important pathway for the translocation of Pu in the body. (auth)

41977 STUDIES ON THE MECHANISM OF THE INCREASED DOSE–RESPONSE OF ERYTHROPOIETIN AFTER STIMULATION WITH ERYTHROPOIETIN. Fogh, Jan (Rigshospitalet, Copenhagen. Univ. of Chicago). Blood; 35: 476-93(Apr 1970). (ACRH-1000-188).

The responsiveness of ESF of the erythremic mouse is increased one to four days after a previous stimulation with ESF. The formation of nucleated red cells by the priming ESF stimulation was suppressed either by simultaneous injections of ESF and Actinomycin D, or by giving the priming ESF challenge to erythremic mice shortly after they had been exposed to 400 R whole-body irradiation with x rays. By these techniques it was demonstrated that the presence of nucleated red cells within the erythron is not important for the observed increase in dose-response of ESF after ESF stimulation. It was concluded that the recruitment of primitive erythropoietin-responding cells is enhanced by ESF. (auth)

41978 SOME OBSERVATIONS ON LYMPHATICS IN THE RAT THYMUS AFTER IRRADIATION. Engeset, A. (Norwegian Hospital, Oslo). pp 20-1 of Progress in Lymphology. II. /Viamonte, Manuel (ed.). New York; Intercontinental Medical Book Corporation (1970).

From 2nd International Congress of Lymphology, Miami Beach, Fla. See CONF-680311.

The effects of a dose of 400 R x radiation delivered either as local irradiation to the thymus or whole-body irradiation on lymphatic vessels and lymphocytes in the rat thymus were studied. Within the first three days following irradiation the weight of the thymus fell to about one-third of the normal weight. Most of the small lymphocytes in the thymus cortex were destroyed within a few hours following irradiation and the cortex was almost devoid of these cells by the second day. Dilated lymphatics were observed within the thymus of some animals. Repopulation of small lymphatics began on the fourth day and by the ninth day following irradiation the irradiated thymus was histologically similar to that in unirradiated controls. (C.H.)

41979 RADIATION EFFECT ON THE BARRIER FUNCTION OF THE LYMPH NODE. Herman, P. G.; Benninghoff, D. L.; Mellins, H. Z. (State Univ. of New York, Brooklyn). pp 260-1 of Progress in Lymphology. II. /Viamonte, Manuel (ed.). New York; Intercontinental Medical Book Corporation (1970).

From 2nd International Congress of Lymphology, Miami Beach, Fla. See CONF-680311.

The appearance of thorium dioxide (Thorotrast) particles in the lymph node, studied by microradiographic methods is a useful semi-quantitative index of the barrier function. Local irradiation of 1000 to 3000 R in single dose had no detectable effect on the filtering function of the popliteal lymph node of the dog. (auth)

41980 EFFECT OF EPINEPHRINE IN OIL ON SUSCEPTIBILITY OF X-IRRADIATED RATS TO EXPERIMENTAL BACTERIAL ENDOCARDITIS. Highman, Benjamin; Rantanen, Norman W.; Hanks, Alan R. (Armed Forces Inst. of Pathology, Washington, D. C. National Institutes of Health, Bethesda, Md.). J. Infect. Dis.; 121: 656-9(Jun 1970).

After two exposures to 400 R, one group of rats, of three groups, were given two subcutaneous injections of epinephrine in oil on successive days and two intravenous inoculations of Streptococcus mitis. The other two groups were inoculated similarly, but one received no epinephrine in oil and the other was not irradiated. The irradiated rats treated with epinephrine had a much higher rate of mortality and incidence of bacterial endocarditis than the other two groups combined. They also had a high incidence of mural vegetations and bacterial masses in small blood vessels of the heart and kidney. Both irradiated groups developed leukopenia of comparable severity. These findings indicate that epinephrine in oil has a synergistic effect in decreasing the resistance of irradiated rats with severe leukopenia to bacterial endocarditis induced by S. mitis. (auth)

41981 PATHOLOGY AND FAMILIAL INCIDENCE OF THYROIDITIS IN A CLOSED BEAGLE COLONY. Fritz, T. E.; Zeman, R. C.; Zelle, M. R. (Argonne National Lab., Ill.). Exp. Mol. Pathol.; 12: 14-30(1970).

Lymphocytic thyroiditis, resembling Hashimoto's disease of man, occurs spontaneously in a closed breeding colony of beagle dogs with an incidence approaching 20% among untreated animals over 1 yr of age. This disease is genetically influenced as determined by an analysis of the ancestral composition of each animal. The incidence increases with increasing degrees of relatedness to three sibling progenitors of a partially inbred line that comprises a major portion of the colony. The pathologic changes in the thyroids cause neither clinical signs nor enlargement of the gland, and the severity of the lesions is independent of age. The lesions do not appear to be progressive in severity or result in atrophy or fibrosis of the gland. The histologic features and total incidence of thyroiditis in adult dogs given lethal or near-lethal doses of ionizing radiation is distinctly different from those of nonirradiated dogs, but the incidence is genetically influenced in the same manner as in nonirradiated adults. Lymphocytic lesions also occur in the thyroids of 55% of stillborn puppies but are dissimilar to those in all adult dogs. The incidence of these lesions, however, is not genetically influenced as are those in adult dogs. Therefore, the diseases in neonatal and adult dogs are different. (auth)

41982 EXPERIMENTAL OTOSCLEROSIS. ITS CAUSATION BY IONIZING RADIATIONS. Mendoza, D.; Ruis, M.; De Stefani, E.; Leborgne, F. Jr. (Facultad de Medicina, Montevideo). Acta Oto-Laryngol.; 67: 9-16(Jan 1969).

Foci of osteogenesis of otosclerotic appearance were radioinduced in the enchondral layer of the otic capsule of dogs. In the first dog five sessions were carried out over 17 days. The total dose given was 8330 and 7920 Rads in the right and left ear, respectively. The second dog underwent six sessions over 22 days and received a total dose of 7920 and 5280 Rads in the right and left ear, respectively. The petromastoid portions of the temporals were fixed in 10% formaldehyde and decalcified in 5% aqueous solution of trichloroacetic acid. The following histologic techniques were performed: H&E, Wilder, PAS and Scarlach red. In the enchondral layer of the otic capsules of the first dog three otosclerotic foci were found in the walls of the internal auditory duct and of the cochlea. In the second dog, a diffuse osteogenic reaction was observed. It was believed that the osteogenic foci obtained fulfill the requirements set out by various authors as demonstrative of experimental otosclerotic lesions. It is furthermore contended that such foci are repair areas in a devitalized enchondral layer with extensive zones of necrosis. (auth)

41983 ELECTROPHORETIC STUDIES ON EPITHELIAL PROTEINS OF THE CORNEA IN EXPERIMENTAL PHOTOPHTHALMIA. Hamerski, Wlodzimierz; Zajaczkowska, Anna. Klin. Oczna; 39: 531-5(1969). (In Polish).

Experimental investigations showed that in the symptom-free 6-hr period of photophthalmia there were quantitative changes in the globulin fraction of the corneal epithelium. These consisted of a decrease of beta-globulin fraction, with simultaneous increase of gamma-globulin fraction. The changes started four hours after irradiation and reached their peak after four hours. (auth)

41984 ISCHEMIA OF THE LUNG DUE TO IONIZING RADIATION: QUANTITATIVE STUDIES. Johnson, Philip M.; Sagerman, Robert H.; Dombrowski, Carl S. (Columbia Univ., New York) J. Nucl. Med.; 11: 491-5(Aug 1970).

The effect of graded doses of ionizing radiation on pulmonary blood flow was measured quantitatively in the Swiss mouse. The experimental data indicate that pulmonary blood flow is reduced following radiation doses ranging from 100 to 4,000 R. The intensity of radioinduced pulmonary ischemia is affected by the size of the radiation dose and the length of survival following treatment. There was no evidence of a limiting process nor of recovery from radioinduced pulmonary ischemia during survival periods extending to half the life span of the experimental animal. (auth)

41985 LASER-INDUCED CATARACT. CLINICAL OBSERVATIONS. Leibowitz, Howard M.; Luzzio, Anthony J. (Army Medical Research Lab., Fort Knox, Ky.). Arch. Ophthalmol. (Chicago); 83: 608-12(May 1970).

Ocular exposure to high levels of unfocused, pulsed, ruby laser radiation results in cataract formation when pupillary miosis is induced prior to irradiation. The clinical course and characteristics of these lens opacities, and of the accompanying ophthalmic sequelae, are described. (auth)

41986 INACTIVATION OF AN X-IRRADIATED TUMOR BY INDEPENDENT PROCESSES IN VIVO. Maruyama, Yoshi; Ackerman, Eugene; Khan, Faiz M. (Univ. of Minnesota, Minneapolis). Int. J. Cancer; 4: 793-8(15 Nov 1969).

An inactivation model is postulated for tumor-cell radiation response in vivo based upon the response to multiple independent processes. These are intrinsic cell radiation response and immunological host resistance. A composite dose-effect relationship that arises is described. Experimental data found with the LSA mouse lymphoma are analyzed and show agreement with the model proposed. (auth)

41987 EFFECT OF PRENATAL X-IRRADIATION ON RESPIRATION AND GLYCOLYSIS OF THE BRAIN IN ONTOGENIC DEVELOPMENT. Owsianowski, Miroslaw (Dept. of Neurology, Medical Academy, Poznan, Poland). Neuropatol. Pol.; 7: 343-57(Jul-Sep 1969).

Irradiation of rabbits on the 18th day of fetal life with a dose of 150 R of x rays disturbed the normal developmental changes of tissue respiration and the anaerobic glycolysis of the brain during ontogenesis. Decrease of oxygen consumption induced by ionizing radiation is seen mainly in the grey matter of the brain and partially in the white matter. The greatest decrease of this process occurs during those developmental periods, in which it assumes the greatest rate in normal animals. The anaerobic glycolysis of the brain of irradiated rabbits decreased mainly in the grey matter in later periods of extrauterine development, coinciding with growth perturbation caused by ionizing radiation. The myelination process of the nervous fibers of the brain of irradiated animals is only slightly retarded. (auth)

41988 RETINAL RECOVERY FROM EXPOSURE TO LIGHT. Kuwabara, Toichiro (Harvard Univ., Boston). Amer. J. Ophthalmol.; 70: 187-98(Aug 1970).

Retinas that have been damaged by light exposure have a definite capacity for recovery. The preservation of the pigment epithelium and the photoreceptor cell body is absolutely necessary for the recovery. When the pigment epithelium is damaged severely by the thermal effect of the light, the photoreceptor cannot survive. When in addition, the photoreceptor cells are damaged totally, the retinal glial cells and the pigment epithelium form a tight interdigitation. Reformation of the lamellar membrane is an extremely slow process and the newly formed membranes lack the ability to form the regular arrangement. Positive ERG responses are obtained concomitantly with reformation of the lamellar membrane. (auth)

41989 EFFECT OF X RADIATION ON RAT FETAL ORAL MUCOSA IN TISSUE CULTURE. Bracho, Miguel A.; Rose, George G.; Cattoni, Martin; Nikai, Hiromasa (Univ. of Texas, Houston). J. Dent. Res.; 49: 852-63(Jul-Aug 1970).

Cultures of oral mucosa from 15- to 17-day-old rat fetuses were placed under cellophane membranes on cover glasses of Rose chambers to determine the action of low doses of x radiation on the oral epithelial cells, exclusive of mitotic phenomena. The principal characteristic of the emigrating cells in control cultures was established. The most important changes in surviving cells of the irradiated cultures were the formation of multinucleated giant cells, cellular vacuolization, and movements of the cell membranes (zeiosis and pericyclosis). Even with the low doses, there was a decided inhibition of growth. (auth)

41990 IMPORTANCE OF THE SPLEEN IN RADIOLOGY: RECENT RESULTS. Diethelm, Lothar; Ladner, Hans-Adolf; Deyhle, Peter (Univ., Mainz). Z. Gesam. Inn. Med. Ihre Grenzgeb.; 24: 501-5(15 Aug 1969). (In German).

Results of experiments on the spleen of rats are given. Regeneration takes place more quickly in the red splenic pulp, whereby erythropoiesis obviously originates from the less radiosensitive and therefore less damaged pluripotent stem cells of the spleen. Besides the differences in response from animal to animal there were also found considerable differences of reaction in the same spleen that can be traced back to biological factors hitherto unknown. Of interest are also humoral processes that are produced in the spleen after radiation and have a negative influence on the regeneration of the bone marrow. Splenectomy leads to an increase of the survival rate after whole-body radiation with sublethal and lethal doses in small and large animals. The uptake of radioiron by several organs is changed by splenectomy after irradiation and detailed results are given. (auth)

41991 FURTHER ANALYSIS OF SLOW SURFACE-NEGATIVE POTENTIALS OF THE CORTEX: ACTION OF X-RAYS AND ANALGESICS. Roitbak, Alexander I. (Inst. of Physiology, Tbilisi, USSR). Acta Biol. Exp., Pol. Acad. Sci.; 29: 125-34 (1969).

In response to a stimulus applied to the surface of the cortex a dendritic potential, that is, EPSP of apical dendrites and slow negativity (SN, 300 to 3000 msec) arise. It was supposed that SN reflects depolarization of apical dendrites resulting from the activation of glia in their vicinity. Experiments were carried out on cats under Nembutal anesthesia with Ag–AgCl electrodes and a DC amplifier. Under x-ray action (15 kR) SN disappeared; dendritic potentials did not alter at that dose, but they disappeared with higher doses of x rays. This fact might be considered as evidence in favor of the neuroglial nature of SN, for there are morphological and physiological data asserting that the neuroglia is more sensitive to x rays than the neurons. With local application to the cortex morphine does not affect dendritic potentials, but enhances primary and secondary responses. SN is the only evoked potential of the cortex that is eliminated as a result of local application of morphine. Analgesics promedole and fentanyl also eliminate SN. Intravenous administration of morphine (3,6 mg/kg) causes weakening and elimination of SN of the direct cortical response and SN of the somatosensory area elicited by strong skin stimulation. Latency of this effect and its duration correspond to the course of the analgesic effect in experiments on normal cats. It may be supposed that the neuroglia is related to the mechanism of pain and is a site of action of morphine and other analgesics. (auth)

41992 BIOLOGICAL EXPERIMENTS WITH THE LASER. Ognev, B. V.; Vishnevskii, A. A. Jr.; Rozenfel'd, E. B.; Malyshev, V. N.; Troitskii, R. A.; Berezina, S. P. (Central Inst. for the Advanced Training of Physicians, Moscow). Eksp. Khir. Anesteziol.; 14: No. 4, 12-17(Jul-Aug 1969). (In Russian).

Rabbits and guinea pigs were used to determine the effect of lasers on blood vessels and malignant tumors. A Soviet-manufactured pulsed neodymium laser OKG-100 with a working capacity of 50 to 70 j was used. The eyes, concha auriculae, abdominal walls, tibia, liver, spleen, stomach, lymph nodes, kidneys, and other organs of rabbits were exposed to laser action. The eyes, lymph nodes, and tibia of guinea pigs were irradiated. Irradiation of the eyes was conducted without anesthesia. Internal organs were irradiated during surgery under local novacaine anesthesia. All experimental rabbits withstood irradiation and surgery well, and were sacrificed one hour to 63 days after the beginning of the experiments. Of the nine experimental guinea pigs, six died within 24 hours after irradiation and the other three were sacrificed one month after irradiation. Examination showed that local irradiation with laser rays destroys blood vessels. Least resistant to the action of the laser rays were the capillaries of irradiated organs and the retina arteries were considerably more resistant. Vascularization in the irradiated organs was not uniformly restored. Blood vessels of a typical structure were formed at the focus of action of the laser, and indirect blood pathways developed. Disintegration of Brown-Pearce carcinoma and its metastases was also noted. (JPRS)

Man

Refer also to abstracts 41757, 41780, 41797, 41889, 41894, 41895, 41897, 41913, 41914, 41916, 41921, and 41946.

41993 (BRH/DBE–70-1, pp 7-8) BEHAVIORAL STUDIES SECTION. (Public Health Service, Rockville, Md.).

A follow-up study was conducted of immigrant children in Israel who received x-ray treatments to the scalp for tinea capitis during 1949 to 1959. The therapeutic procedure was estimated to deliver about 500 rads to the scalp and about 150 rads to the surface of the brain. Late effects of irradiation, particularly in the form of central nervous system disorders, mental retardation, mental illness, and malignancies are being studied. (H.L.W.)

41994 (BRH/DBE–70-1, pp 9-15) SOMATIC STUDIES SECTION. (Public Health Service, Rockville, Md.).

The Somatic Studies section is concerned with human populations exposed to sources of ionizing and nonionizing radiation. Utah–Nevada–Arizona studies of fallout effects were conducted to determine the possibility of thyroid injury to Utah children as a consequence of their consuming milk contaminated with ^{131}I derived from nuclear detonations at the Nevada Test Site. A national registry of radiation incidents was initiated for compiling information on date and location of the incident, the type of facility and kind of radiation, and the age, sex, and occupation of persons affected by the incident. A radiation pathology registry was established for compiling information on tissues from patients known to have been irradiated. Studies were also conducted on electron microscopy of the thyroid gland; mortality, health indexes, and radiation correlations; Thorotrast effects on man; diagnostic radiation in short-stay general hospitals; atomic bomb casualty commission reports; effects of background radiation on congenital malformations; diathermy related effects; and effects of x radiotherapy on the human fetus. (H.L.W.)

41995 (N–70-14263) IONIZING RADIATION AND MAGNETIC FIELDS: A REVIEW OF THEIR EFFECTS ON THE NERVOUS SYSTEM. Galiana, H. L. (Massachusetts Inst. of Tech., Cambridge. Man-Vehicle Lab.). Feb 1969. 30p. (NASA-CR-107358; MVLS-69-1). CFSTI.

Data on the functional sensitivity of the nervous system to ionizing radiation and magnetic fields suggest caution in prolonged human exposure to similar environments. Unfortunately, the conditions investigated are also characteristic of those expected during a space flight. Studies are thus needed to determine the nature and mechanism(s) of the nervous system's reactions to these and other factors, and to investigate the degree to which the astronaut's performance capabilities may be affected. Such knowledge would also prove helpful in determining protection standards for occupationally exposed personnel and in medical research. (STAR)

41996 (RLO–1780-26) EFFECTS OF IONIZING RADIATION ON THE TESTICULAR FUNCTION OF MAN. Progress Report. Heller, Carl G. (Pacific Northwest Research Foundation, Seattle, Wash.). May 1970. Contract AT(45-1)-1780. 50p. Dep. CFSTI.

Biopsy samples obtained from 16 minutes up to 240 weeks following irradiation of human testes with doses of x radiation ranging from 8 R to 600 R were examined for cytological evidence of radiation injury to spermatogonia, spermatocytes, spermatids; Leydig cells, and Sertoli cells. The sperm content in seminal fluid and the content of estrogens in blood plasma and urine were also measured. Results showed that the secretory activity of Leydig cells is apparently depressed by irradiation since urinary testosterone levels were decreased in all men. Ultrastructural damage of testicular cells were observed immediately following irradiation. 118 references. (C.H.)

41997 CASE REPORT OF A RADIOINDUCED CANCER. Labayle, J. J. Fr. Oto-Rhino-Laryngol.; 16: 269-70(Apr 1967). (In French).

Five cases of osteomyelitis of the frontal bone and one of parietofrontal osteomyelitis are reported (four adults and two children). Two cases occurred when antibiotics were not used, but the others are recent. One death occurred. Four patients suffered from a preexisting frontal sinusitis; in one case, a typhous osteitis was involved and in another case, a probable primative osteomyelitis with secondary sinusitis. Treatment by antibiotics is now the major method, permitting limited operations afterwards. The resection of the bone, nevertheless, always leads to a more or less broad meningeal denudation. The affection has become more rare and is now nearly always curable. (TSS) (auth)

41998 IATROGENIC DISORDERS IN THE FIELD OF RADIOTHERAPY. Fukuda, Masashi; Abe, Mitsuyuki (Kyoto Univ.). Jap. J. Clin. Radiol.; 14: 533-8(Jul 1969). (In Japanese).

Radiotherapy is inevitably accompanied by radiation hazards, so it is not reasonable to regard temporary and reversible changes as iatrogenic disorders. Delayed and persistent disturbances due to irradiation are listed as iatrogenic disorders in radiotherapy. Skin injuries are inevitable in radiotherapy, and teleangiectasia, thickening of skin, and induration of subcutaneous tissues result. There are two types of radiation cataracts; one is progressive and ends in complete blindness, and the other inflicts only initial small opacity of lens but visual capacity is retained. Radiation myelitis is brought about in several percent of cases where the spinal cords are irradiated with a dose of about 5000 R. The occurrence of radiation fibrosis of the lung is more related to the irradiated volume rather than to the dose. After radiotherapy to the pelvic cavity, ulcers and fistulae of the rectum and bladder, and cicatrization and stenosis of the ureteral orifice are sometimes observed. When the kidney is irradiated with a total dose above 2000 R, renal disturbances such as nephritis, hypertension, and asymptomatic albuminuria are sometimes observed. Bone injuries such as arrest of growth, osteonecrosis, osteoporosis, and provocation of osteosarcoma are found. In patients treated with ^{131}I, hypothyroidism is sometimes induced. The incidence of leucemia increases after external irradiation or ^{32}P internal administration, and the incidence of thyroid cancer increases in patients subjected to radiotherapy of the head and neck, or of the chest in their youth. (NSA of Japan)

41999 GINGIVAL AND MANDIBULAR INJURY AFTER THE RADIOTHERAPY OF ORAL CANCERS. Horiuchi, Junichi; Okuyama, Takeo (Tokyo Medical and Dental Univ.). Jap. J. Clin. Radiol.; 14: 622-6(Aug 1969). (In Japanese).

The gingival and mandibular injury mentioned here represents atrophy and loss of gums, and exposure and necrosis of mandible

occurred after radiotherapy. The conditions causing this injury were studied on 50 cases of oral cancers with no local recurrence more than 2 yr after the radiotherapy. The results obtained were as follows: Doses to gums in 22 cases treated by small radiation sources alone were 2500 Rad/3 days to 10,000 Rad/15 days, no injury occurred in any case. Of 25 cases subjected to the combined therapy of small radiation sources with external irradiation, five cases demonstrated this injury. The doses in the five cases were more than 10,000 Rad/20 days. The doses of three cases treated by external irradiation alone were 4500 to 5000 Rad/15 days, and none of the cases demonstrated this injury. From the above results, this injury seems to develop when a massive dose of about 10,000 R is given homogeneously and widely to bone as well as to gums within a relatively short period of about 20 days. Further, the extraction of teeth after irradiation and the deficiency of oral autopurification due to radioinduced oligosialia seem to often introduce this injury. Because there is no proper medical treatment for this injury, emphasis should be placed on prophylaxis. The prolongation of overall time in the combined therapy of small radiation sources with external irradiation, the use of electron beam in order to avoid the irradiation of bone, the proper choice of time for the extraction of teeth, and adequate oral management are required to prevent this injury. (NSA of Japan)

42000 RADIONECROSIS DUE TO ^{192}Ir. Degos, R.; Gaultier, M.; Fournier, E.; Daniel, F.; Reboul. Bull. Soc. Fr. Dermatol. Syphiligr.; 76: 19-20(1969). (In French).

A case of radionecrosis is reported resulting from a 2 to 3 min exposure to pure γ on the hands of a person attempting to repair a radiometallographic device with bare hands in direct violation of very rigid rules. On the fourth day after irradiation the palm of the right hand was covered with blisters of acute radiodermatitis. Simple antiseptic treatment was undertaken, and the blisters receded slowly over a six-week period. A month after the irradiation an erythemato-infiltered area of the left submammary region appeared, covered very rapidly by blistery peeling. The patient was treated by local fatty dressings, anabolic agents, and analgesics. This blistery lesion was replaced slowly by ulceration. The patient has shown no major hematological anomaly. The ulcerated area will probably have to be treated surgically. The results of genetic studies are not complete. (J.S.R.)

42001 RADIATION-INDUCED BREAST CANCER. Mole, R. H. (Medical Research Council, Harwell, Eng.). Lancet; 1: 524-5(7 Mar 1970).

The problems of deducing the dose-response curve for radiation induced breast cancer are discussed, together with the relation of irradiation to other cancers and radiation injuries. Results depend on good radiation dosimetry. Studies of patient records having fluoroscopies during pneumothorax therapy for tuberculosis, surveys of patients who have x-ray treatment for ankylosing spondylitis, bomb survivors, and radiation dermatitis, particularly with regard to radiation workers, are mentioned. (UK)

42002 CONCERNING THE STATE OF BONES AFTER RADIOTHERAPY OF SKIN HEMANGIOMAS IN CHILDREN. Svistunova, T. M. (Research Inst. of Oncology, Leningrad). Vop. Onkol.; 16: No. 3, 112-17(1970). (In Russian).

To recognize the condition of underlying bones after low-voltage x-ray therapy of skin located over the growth zones control roentgenograms were obtained following 5 to 10 years and longer after termination of treatment in 42 children. Hemagiomas mainly showed a rapid growth, some of them being ulcerated. Their size varied from 5 to 100 cm^2 and greater. Children at the age from 3 weeks to 5 months were treated. Irradiation was performed with a voltage of 40 kV and a filter of 0.5 to 1.0 mm Al (SPO-0.2-0.8 mm Al), RIK-7.5 to 10 cm. Total dosage was 1500 to 3100 R. Roentgenographic studies of bones and the bone-joint apparatus in all these children did not reveal any changes relative to the ionizing radiation action that could be explained by individual technic of irradiation. (auth)

42003 HISTOLOGICAL STUDY OF CHRONIC OCCUPATIONAL X-RAY DERMATITIS OF THE FINGERS. Lagrot, F.; Mussini-Montpellier, J.; Streit, R. (Univ., Toulouse). Sem. Hop. Paris; 46: 866-78(14 Mar 1970). (In French).

Ninety-six operated cases, including 51 for malignant change, are reported. The lesions are described and an account of their course is given. The importance of vascular disorders of the dermis and dysplasia of the Malpighian layer of the epidermis in the onset of carcinoma is shown. These changes are considered premalignant from their onset. The lesions are classified as follows: Simple radiodermatitis, Grade I involutive, Grade II dysplasia; x-ray dermatitis carcinoma in situ; x-ray dermatitis with invasive carcinoma. The mechanism of this malignant degeneration from precancer to carcinoma in situ and from the latter to invasive carcinoma is discussed. In any case surgical removal is necessary. (auth) (France)

42004 RADIATION EXPOSURE FROM A SHOE-FITTING FLUOROSCOPE. Bushong, Stewart C.; West, Walton D. (Texas Medical Center, Houston). Health Phys.; 18: 575-7 (May 1970).

The radiation hazard that existed when shoe-fitting fluoroscopes were in general use is reviewed. Figures are given of the exposure rates which were measured at various positions around such a machine which was recently operated for this purpose. (UK)

42005 ACQUIRED LYMPHANGIOMA (LYMPHANGIECTASIS). Fisher, Isadore; Orkin, Milton (Univ. of Minnesota, Minneapolis). Arch. Dermatol.; 101: 230-4(Feb 1970).

Verrucose lymphangioma-like lesions appeared on the vulva of an elderly woman several years after irradiation for squamous cell carcinoma of the cervix uteri. The lesions have the appearance of benign lymphangioma cutis but are located bilaterally and have developed late in life. The alternate diagnosis of lymphangiectasis was made despite the lack of preceding or accompanying edema. This condition can be compared with lymphangiosarcoma. (H.L.W.)

42006 ALLOGENEIC MARROW ENGRAFTMENT FOLLOWING WHOLE BODY IRRADIATION IN A PATIENT WITH LEUKEMIA. Buckner, C. Dean; Epstein, Robert B.; Rudolph, Robert H.; Clift, Reginald A.; Storb, Rainer; Thomas, E. Donnall (Univ. of Washington, Seattle). Blood; 35: 741-50(Jun 1970).

A 46-year-old man with blastic crisis of chronic myelogenous leukemia was given 950 rads whole-body γ irradiation followed immediately by 17.6×10^9 marrow cells. The marrow donor was the patient's sister who matched the patient in 11 of 12 HL-A groups and whose leukocytes reacted to the patient's leukemic cells in mixed leukocyte culture. The patient's white blood cell count began to go up on the 13th day and marrow engraftment was confirmed by repeated cytogenetic analyses. Secondary disease with skin rash and diarrhea was evident by the end of the second week but appeared to be controlled by methotrexate. The patient then developed fever, recurrent diarrhea and pneumonitis and died 56 days after irradiation. Autopsy showed inclusion bodies typical of cytomegalovirus. There was no histological evidence of acute secondary disease nor of leukemia. (auth)

42007 OCULAR COMPLICATIONS AFTER THERAPEUTIC IRRADIATION. Macfaul, P. A.; Bedford, M. A. (Moorfields Eye Hospital, London. St. Bartholomew's Hospital, London). Brit. J. Ophthalmol.; 54: 237-47(1970).

Radiotherapy has a valuable place in the treatment of neoplastic disease of the eye and orbit. Conventional x rays and modern radiotherapeutic techniques may lead to complications, the majority of which are of relatively minor importance. Cobalt plaques are being increasingly used in centers throughout the world and are proving of considerable value for otherwise incurable conditions. Increasing awareness of their side-effects, particularly on the optic nerve, should lead to careful consideration not only of the size but also of the site of the neoplasm, bearing in mind the very high radiation dose inevitable with this technique. Further work is being done to define more closely the indications for the application of cobalt plaques in the area of the optic disc and to elucidate the pathology of the vascular changes in radiation retinopathy. (auth)

42008 DENTAL LESIONS CAUSED BY IRRADIATION. Mikkelsen, Lena; Bendixen, Poul. Tandlaegebladet; 72: 910-6(Oct 1968). (In Danish).

A case of radiation damage to the developing permanent teeth and other oral tissues following radiotherapy of a malignant tumor in the eye of a 2-year-old child is presented. At the age of 8 years cicatrization of patient's skin and oral mucosa is still evident, and disturbances in the development of the jaws are noted. Damages to the permanent dentition comprise destruction of tooth germs, arrested tooth development, microdontia, and underdevelopment of roots. Caries activity appears somewhat enhanced. The importance of effective shielding of the surrounding tissues during radiotherapy is stressed. Problems concerning dental prophylaxis and therapy in irradiated patients are discussed. (auth)

42009 SPECTRAL DEPENDENCE OF RETINAL DAMAGE PRODUCED BY INTENSE LIGHT SOURCES. Mainster, M. A.; White, T. J.; Allen, R. G. (Technology Inc., San Antonio). J. Opt. Soc. Amer.; 60: 848-55(Jun 1970).

Retinal-temperature increases produced by circularly symmetric exposures to electromagnetic radiation between 400 and 1200 nm were calculated for a wide range of image sizes. Temporal, axial, and radial temperature distributions are described. Constant and

exponentially decreasing source strengths are considered. Solutions of the heat-conduction equation are expressed in terms of both retinal irradiance and the total power entering the eye. Application of solutions to the prediction of thresholds for retinal damage is discussed, and excellent agreement is noted between theoretical predictions and experimental observations of the spectral dependence of chorioretinal damage thresholds. (auth)

42010 RELIGION AND ETHNICITY IN LEUKEMIA. Graham, Saxon (State Univ. of New York, Buffalo); Gibson, Robert; Lilienfeld, Abraham; Schuman, Leonard; Levin, Morton. Amer. J. Public Health; 60: 266-74(Feb 1970).

Research on the Tri-State Leukemia Study population showed no difference among child cases and controls in religious and ethnic background, nor indeed on any demographic parameter. Among the over 1,200 adult cases and 1,200 adult controls, however, Jews, Russians, and Poles all had significantly elevated risks. For Russian-Jews, however, the risk was over five times that of non-Jews born in the United States. They exceeded other groups that were culturally similar to themselves in smaller degree than those that were more dissimilar culturally. There was no difference histologically in the distribution of Jewish and non-Jewish cases, and the Russian and Jewish relationship appeared to persist in both the irradiated and nonirradiated populations. (auth)

42011 SEARCH FOR LATE RADIATION EFFECTS AMONG MEN WHO SERVED AS X-RAY TECHNOLOGISTS IN THE U. S. ARMY DURING WORLD WAR II. Miller, Robert W.; Jablon, Seymour (National Cancer Inst., Bethesda, Md. National Research Council, Washington, D. C.). Radiology; 96: 269-74 (Aug 1970).

A study was made of 6,560 males trained as radiological technologists by the U. S. Army during World War II. Mortality by cause for x-ray technologists was compared with that for men trained by the Army as pharmacy or medical laboratory technologists. No significant excess of leukemia existed among x-ray technologists; but 17 died of respiratory tract cancer relative to four among the controls. This difference, statistically significant at the 5% level, was due in part to a smaller than usual number of such deaths among the controls. Questionnaires revealed no evidence of radiation effect on sex ratio of children fathered by x-ray technologists. (auth)

42012 THORIUM-DIOXIDE GRANULOMA WITH LARYNGEAL PALSY. Kobayashi, Takeo (Tokyo Univ.); Matsuura, Tei. Arch. Otolaryngol.; 92: 272-4(Sep 1970).

A case is presented of associated laryngeal paralysis due to thorium dioxide (Thorotrast) granuloma of the neck. This was caused by accidental extravasation at the time of carotid angiography 20 yr previously. Phonosurgical repair was successful. (auth)

42013 RESPONSE OF NORMAL LYMPH NODES TO CANCEROCIDAL RADIOTHERAPY AS SHOWN BY SECOND LOOK LYMPHOGRAPHY. Thornbury, J. R. (Milheim Cancer Foundation, Denver). pp 196-8 of Progress in Lymphology. II. /Viamonte, Manuel (ed.). New York; Intercontinental Medical Book Corporation (1970).

From 2nd International Congress of Lymphology, Miami Beach, Fla. See CONF-680311.

The abdominal and pelvic lymph systems of 10 patients with carcinoma of the uterine cervix were examined by contrast media lymphography before and three weeks to six months following fractionated dose γ therapy with total doses of 5000 to 7000 Rads. A comparison of the pre- and post-irradiation lymphograms showed that normal lymph nodes within the treatment field generally became smaller but the configuration of normal lymphatic trunks was not affected by these dose levels. (C.H.)

42014 SOME RESULTS OF A STUDY OF RADIATION INJURY OF THE SKIN AND PATHS FOR FURTHER RESOLUTION OF THIS PROBLEM. Babayants, R. S. Vestn. Dermatol. Venerol.; 42: 11-6(Mar 1968). (In Russian).

A review of formation and further development of studies of skin pathology arising under the effect of different kinds of ionizing radiation on man is given. Further approaches for its solution are outlined: necessity of more profound investigation of the effect of small doses, mechanisms of development of functional disorders, in particular, at early stages of the development of radiation pathology of the skin; clinical patterns in combined lesions, histochemistry, elucidation of whether the term "radiosensitivity of the skin" is justified and scientifically grounded; as well as a study of comparative effectiveness of drugs used at the present time in radiochemical industry for decontamination of the skin and washing. (auth)

42015 BARRIER FUNCTION OF THE LYMPH NODES IN THE NECK OF THE HUMAN. Fisch, U. Progr. Clin. Cancer; 4: 97-108(1970).

The experimental knowledge of the barrier function of human lymph nodes is limited. The experimental investigation of the lymphatic filtering function by perfusion with a suspension of avian erythrocytes of the lymph nodes removed by radical neck dissection in man following local ^{60}Co γ irradiation is reported. (auth)

42016 LASER EYE HAZARD. Landers III, Maurice B. (Duke Univ., Durham, N. C.). Surr. Ophthamol.: 14: 338-41 (1970).

Ocular hazards attendant to the use of lasers are discussed. Attention is focused on the eye because it is the most sensitive target for those wavelengths that traverse the ocular media. Gas lasers, such as the infrared carbon dioxide laser, are particularly hazardous to surface tissues, i.e., cornea, skin. The visible wavelength lasers are also hazardous to the eye because of the high-energy densities produced at the retina. Ultraviolet lasers present only a limited hazard to the eyes because essentially all of the incident radiation is absorbed by the cornea, aqueous, or lens. Thermal injury, such is seen in arc welders, could be produced. The extent of retinal damage incurred by visible light lasers is dependent upon the type of laser and the mode of operation. Occupational hazards incidental to the use of lasers are also discussed. These include coolant burns, electric shock, gas exposure, and explosion of various components. The treatment of laser injuries to ocular tissues is mentioned. (E.R.B.)

42017 PRIMARY MALIGNANT TUMORS OF THE FEMALE GENITAL SYSTEM APPEARING YEARS AFTER RADIATION TREATMENT FOR MALIGNANT NEOPLASMS OF THE GENITAL SYSTEM. Grattarola, R.; Evoli, M. (Istituto Nazionale per lo Studio e la Cura dei Tumori, Milan). Minerva Ginecol.; 20: 242-6(15 Feb 1968). (In Italian).

Data are comprised of six patients who developed malignancies after a time lag of many years after treatment for malignant disease of the cervix (four patients), of endometrium (one patient), of ovary (one patient). The postirradiation malignancies were four endometrial adenocarcinoma, two uterine fibrosarcoma, one ovarian adenocarcinoma. Radiation therapy was instituted by combination of radium (56.7 m.c.d. total dose) and X-ray (6,000 R) in two patients with cervical carcinoma and by radium alone (56.7 m.c.d.) in the other two patients with cervical carcinoma. In three patients after 11 years and in one patient after 17 years an endometrial carcinoma developed and in one patient after 11 years a uterine fibrosarcoma. The patient with endometrial carcinoma was treated by radium alone, and 10 years later she was affected by an ovarian adenocarcinoma. One patient, after surgical removal of one ovary for malignancy was treated by X-ray (5,000 r) and three years later was affected by a uterine fibrosarcoma. (auth)

42018 RADIATION CATARACT AFTER TREATMENT WITH PETEOSTHOR (THORIUM X). Honegger, H. (Univ., Heidelberg). Klin. Monatsbl. Augenheilk.; 155: 890-5(Dec 1969). (In German).

In a 48-year-old male patient, a bilateral cataract with the typical features of a radiation cataract occurred at the age of 34 years, 5 to 6 years after intravenous treatment with Peteosthor with a total dose of 13.800 e.s.E. Thorium X. From the clinical point of view, everything pointed to a radiation cataract from Peteosthor therapy. It was discussed that this cataract in the sense of a permeability cataract may arise from a lesion of the ciliary body by alpha- and beta-irradiation because thorium X and the breakdown product thorium B are stored in the ciliary body. Furthermore, a direct beta-irradiation of the lens from the ciliary body is possible. (auth)

42019 URINE-FLOW DISORDERS AS COMPLICATION FOLLOWING RADIOTHERAPY. Breit, A. Langenbecks Arch. Chir.; 325: 644-53(1969). (In German).

The local effect of radiation on the ureter depends on the dose employed, or the manner in which applied and the radiation-technique employed. Exogenous factors, such as inflammatory changes or tumorous growths in the area of the ureter also play a part. The combination of a functional examination (isotope nephrogram) and morphological presentation with the pyelogram frequently discloses early changes in the form of a disturbance in urine flow when high doses (somewhat over 4000 R) are employed. However, in most cases, these changes revert to normal. Additional vascular damage, as shown by pelvic arteriography quite some time after cobalt-radium therapy, may play some part in later changes. The tolerance threshold of the ureter would appear to be under normal conditions between 6000 and 7000 R. (auth)

42020 RADIATION-INDUCED SARCOMA AFTER TREATMENT OF BREAST CANCER. Senyszyn, John J.; Johnston, Austin D.; Jacox, Harold W.; Chu, Florence C. H. (Columbia Univ., New York. Memorial Hospital, New York). Cancer; 26: 394-403(Aug 1970).

Two case reports are presented of radiation-induced sarcomas occurring 23 yr and 7 yr after radiotherapy for breast carcinoma. One patient developed an undifferentiated sarcoma of the scapula believed to be induced by a calculated dose to the soft tissue component of bone of 8,195 rads in 3 weeks. The second patient had a fibrosarcoma involving the soft tissues of the axilla. Both patients died several months after diagnosis of the second neoplasm. A review of the literature disclosed 12 other cases in which a malignant tumor developed under similar circumstances. An analysis of these 12 cases and the 2 reported here showed that the most frequent site for the development of a malignant tumor was the scapula, and osteogenic sarcoma was the predominant histologic type encountered in these cases. Treatment with radical surgery or radiation was usually unsuccessful because most patients developed metastases early. A study of the reported cases brought out the fact that incompletely reported dosages made it impossible to calculate accurately doses of radiation absorbed in the target tissues. The authors present a scheme for presenting precise and informative physical data when future cases of radioinduced tumors are encountered. In order to diagnose these cases more accurately, criteria for evaluating the patient are presented. (auth)

42021 THYROID CARCINOMA AFTER IRRADIATION. CHARACTERISTICS AND TREATMENT. Wilson, Stephen M.; Platz, Charles; Block, George M. (Univ. of Chicago). Arch. Surg.; 100: 330-7(Apr 1970).

Sixty-one patients suffering from carcinoma of the thyroid and who had received prior irradiation to the head and neck were studied. Eighty percent of the patients were female, 98% were white, and the average age at the time of diagnosis was 26.7 yrs. The majority of the patients were irradiated as children for thymic or tonsillar disease. However, 30% were irradiated as adults. Biologic predisposition was found to be operative in this series favoring the development of this disease in the female with blood type A (60%) and selectively protecting those with type O (18%). The patients were also studied from the aspect of treatment and the details of this are stated. On the basis of our experience we found that this type of carcinoma of the thyroid arising after irradiation is characterized by local invasion (60%), high recurrence rate (39%), low mortality (5%), and a prolonged clinical course (10-year survival 98%). We advocate the use of near-total thyroidectomy for patients when their disease is confined to the thyroid gland. In addition to a near-total thyroidectomy, a modified neck dissection, preserving the sternocleidomastoid muscle, is advocated. This treatment produces a much more cosmetically appealing result than the standard radical neck dissection. Pulmonary and other distant metastases were best treated by radioactive sodium iodide. The data collected in the series could not support the use of thyroid suppression for the control of local or regional disease as 60% of the patients so treated developed recurrent disease. (auth)

42022 IMPORTANCE OF RADIOTHERAPY IN THE PATHOGENESIS OF CHONDROPERICHONDRITIS IN LARYNGEAL CANCER. Litkevich, O. N. Vestn. Otorino-Laringol.; 30: 83-6 (1968). (In Russian).

Morphohistochemical investigations were carried out of the tissue of the epiglottal and arytenoid cartilages in 33 radium treated and 19 nontreated patients with cancer of the pharynx. During irradiation a disappearance from the main substance of parachondric connective tissue and capillaries of highly polymerized acid and nonsulfatized polysaccharides, loosening of bundles of collagenous fibers, and discharge of fibrin is observed. The cartilaginous tissue, not affecting the neoplastic tissue, is resistant to irradiation in the therapeutic doses employed. In neoplastic involvement of the cartilage from its main substance and cytoplasm of chondrites highly polymerized acid sulfatized mucopolysaccharides, as well as glycogen from cartilaginous cells disappear. This seems to be conductive to the development of chondronecrosis during irradiation. (auth)

42023 TEETH WITHIN THE IRRADIATION BEAM. Elfenbaum, Arthur. Dent. Dig.; 76: 190-2(Apr 1970).

A clinical example is given of a rampant carious condition of the teeth induced by x rays used in the treatment of a brain tumor. The teeth affected to the greatest degree were within the area of the radiotherapeutic beam. Damage occurred not only to the teeth, but to the jawbone and salivary glands as well. The severity of the carious condition was revealed by x-ray examination, but the patient died before treatment could be initiated. The general consensus was that if teeth are located within the proposed field of irradiation, they should be extracted and adequate evidence of postextraction healing obtained before radiotherapy is instituted. (E.R.B.)

42024 LATE RADIATION INJURIES OF THE SMALL INTESTINE. Graudins, J. (Medizinische Akademie, Luebeck, Ger.). Langenbecks Arch. Chir.; 324: 120-30(28 Apr 1969). (In German).

Radiation injury of the small intestine is not too rare a complication after radiotherapy of female genital carcinoma. From 15 observations at the Surgical Clinic of the Medical Academy of Lübeck the symptoms and the clinical descriptions were given. Surgical resection of the damaged part of the intestine should always be tried. (auth)

Radiation Effects on Plants

Refer also to abstracts 41738, 41754, 41774, 41799, 41800, 41802–41813, 41820–41848, 41850–41852, 41854, 41857, 41859, 41948, and 41949.

42025 (ANL-7635, pp 303-12) PLANT RADIOBIOLOGY. (Argonne National Lab., Ill.).

Studies were continued on the origin of auxin in the urine of mice. IAA was identified in germ-free and conventional mice by chromatographic resolution and biological activity. Tryptophan-IAA enzyme activities were the same in germ-free and conventional mice. Carbon-14-labeled tryptophan introduced into the peritoneal cavity of both germ-free and conventional animals gave rise to labeled IAA in the urine. It is suggested that microorganisms may not be mandatory for the activation of the auxin-producing enzyme in the x-irradiated mice. Effects of white and far-red light on cytology and growth of Haplopappus gracilis cells in suspension cultures were studied. Effects of white and far-red light on ribulose-1,5-diphosphate carboxylase activity in Avena sativa and Phaseolus vulgaris were studied using ^{14}C as a tracer. Correlations between respiration and cyclic flowering pattern in Xanthium were investigated. Experiments designed to assess the relative importance of air, water, and soil as sources of lead in perennial ryegrass and radishes showed that only air and soil were significant sources. Tropical marine algae were analyzed for total organic material, protein, nitrogen and calcium, ^{226}Ra, ^{232}Th, ^{238}U, and alpha-particle emitters. (H.L.W.)

42026 (ANL-7635, pp 313-31) GROWTH AND DEVELOPMENT OF PLANTS IN COMPENSATED GRAVITATIONAL, MAGNETIC, AND ELECTRICAL FIELDS. (Argonne National Lab., Ill.).

The effects of gravity compensation and x radiation on the volume, DNA, and symmetry of the nuclei of Vicia faba roots were analyzed. Mean numerical volumes were diminished both by gravity compensation and by x radiation. Irradiation of the plant reversed completely the effects of compensation on mean volumes, and compensation had a similar effect on the action of radiation. DNA contents of interphase nuclei were not materially affected by either radiation or compensation. Reciprocity between presentation time and force in the activation of geotropism of oats grown on clinostats was demonstrated. The role of the Golgi apparatus in geotropism of oats was investigated. Cytological observations were made on early stages of germination in oats. Studies were conducted on the effects of audiofrequency sound on the growth of oat shoots, effects of the length of the period of preplanting imbibition on subsequent growth and georesponse of oat seedlings, and growth rates of the oat coleoptile. (H.L.W.)

42027 SEED YIELD AND QUALITY IN WHITE SPRUCE SELF-POLLINATED WITH GAMMA-IRRADIATED POLLEN. Rudolph, T. D. (Inst. of Forest Genetics, Rhinelander, Wis.). pp 207-17 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Mature pollen from three white spruce (Picea glauca (Moench) Voss) trees was irradiated with ^{137}Cs gamma rays at exposures of 150, 300, 450, 600, 900, 1200, 1800, 2400, 3600, 4800, 7200, 9600, 14,400, 19,200 and 28,800 R at a dose rate of 6000 R/hour. Female strobili on each of the three selected trees were self-pollinated with the irradiated pollen. Moisture content of the three pollen lots of the time of irradiation was 9.8, 11.7, and 15.8%, respectively. The yield of filled seed and seed viability indicated an LD_{50} ranging between 4000 and 12,600 R for the three pollens, depending upon the endpoint used. Variation in pollen sensitivity among trees

was evident, suggesting genotypic differences. Stimulation in yield of viable seed apparently occurred at pollen exposures below 3600 R in two of the three trees studied, indicating genotypic variation in the stimulation response. A continuous decrease in yield of filled seed was noted at pollen exposures above 3600 R. An average of less than 1% of the seed produced was filled or viable at the 19,200-R exposure, and no viable seed was produced after self-pollination with pollen exposed to 28,800 R. Thus, the LD_{100} exposure for white spruce pollen, as determined from seed yield and quality analysis following self-pollination, would appear to range from 20,000 to 30,000 R, depending upon the genotype and the endpoint used. This study showed that white spruce pollen tolerated up to three times as much radiation as seeds and more than 10 times as much as young seedlings. (auth)

42028 NUCLEAR AND CYTOPLASMIC RADIOSENSITIVITY OF CONIFER POLLEN. Stairs, G. R.; Houston, D. B. (Univ. of Wisconsin, Madison). pp 219-30 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

The radiosensitivity of premeiotic male buds from pine trees was examined in an exposure range of 0 to 2 kR. From this study it is suggested that treatment of male buds for mutation induction work in conifers be restricted to values below 1 kR. In-vitro germination trials with pollen indicated an LD_{50} at 300 to 400 kR; pollen tube growth exhibited an LD_{50} level at 400 to 600 kR. At these levels pollen germination and tube elongation are independent of nuclear control and represent metabolic activity in the cytoplasm. Regression analysis of seed germination obtained from breeding studies with irradiated pollen demonstrated significant decreases as the level of exposure increased. An LD_{50} level occurred at 4 to 6 kR; extrapolation of the regression line suggested that 24 to 26 kR may be a reasonable representation of the upper limit of pollen nuclear viability for most conifer species. Exposure levels of 4 to 12 kR are recommended for use in gametic irradiation breeding programs for the conifers. No seed germination occurred for approximately 20,000 seeds obtained from pollen exposed to levels of 50 to 400 kR and thus no evidence was obtained to indicate parthenogenic development. Results of an electron spin resonance spectroscopy study of irradiated pollen, although not entirely conclusive, indicated that the technique may have application in pollen irradiation breeding programs. Further studies are suggested especially in the exposure range from 4 to 50 kR to define and characterize more fully derived spectra under varying experimental conditions. (auth)

42029 RELATIONSHIP OF RADIATION-INDUCED DAMAGE IN BARLEY SEEDS TO THE INHIBITION OF CERTAIN OXIDOREDUCTASES BY SODIUM AZIDE. Sideris, E. G.; Nilan, R. A.; Konzak, C. F. (Washington State Univ., Pullman). pp 313-22 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

The implication that certain oxidoreductases were involved in the mechanism of induction, prevention or repair of radiation-induced cytogenetical and seedling damage was investigated. It was envisioned that the results of manipulating the metabolic activity of the seeds might provide a basis for a more favorable use of the mutagenic properties of ionizing radiations. Sodium azide, an inhibitor of catalase, peroxidase and terminal cytochrome oxidase, was chosen for this investigation. Catalase, as well as peroxidase, may be important in the destruction of the early chemical mutagenic products induced by irradiation, while the inhibition of cytochrome oxidase would interfere with repair processes at the chromosome level. In experiments without irradiation, barley seeds were hydrated in azide solutions buffered at pH 3, 7 and 11. Seedling growth was strongly reduced only in the material treated at pH 3. An inhibitory effect of azide on the respiration of barley seeds was evident at pH 3, while at pH 11 an increase in oxygen absorption was found. Catalase was strongly inhibited at pH 3 and 7 and slightly at pH 11. Peroxidase was inhibited strongly only at pH 3. To study the interaction between the inhibition of these enzymatic systems and the radiation-induced damage, barley seeds were irradiated and hydrated in azide solutions. The chromosome aberrations and the seedling height were used as criteria to find whether an interaction was present. The azide strongly enhanced the irradiation-induced damage at pH 3 and slightly at pH 7, while at pH 11 no synergism was present. The results obtained indicate that under conditions favoring a strong inhibition of catalase, peroxidase and cytochrome oxidase a synergistic effect is present between ionizing radiation and azide-induced damage. This synergism, resulting in an enhancement of the radiation-induced damage, is not evident at higher pH where no inhibition of the enzymatic activity was observed. (auth)

42030 POSSIBILITY OF PRODUCING MALE STERILE FORMS AND RESTORING FERTILITY IN MAIZE BY MEANS OF GAMMA-RAY AND FAST-NEUTRON IRRADIATION. Stoilov, M. (Inst. of Genetics and Plant Breeding, Sofia). pp 509-15 of Induced Mutations in Plants. Vienna; International Atomic Energy Agency (1969).

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash. See STI/PUB-231; CONF-690703.

Seeds of a few inbred lines, hybrids and cultivars of maize were treated with gamma rays and fast neutrons. Along with other changes, some male sterile plants were obtained in the different generations (M_2-M_4). Their frequency ranged between 0.20 and 7.92%. Analyses of test crosses with several established lines (non-restorers and restorers) have revealed the evidence of cytoplasmic male sterility and also of nuclear male sterility. The type of cytoplasmic male sterility thus produced has not yet been determined. In three years of experiments with irradiation of seeds from cytoplasmic male sterile lines and fertile analogs, no changes in respect to sterility or fertility manifestations have been observed. All lines remained sterile or fertile, respectively. When, however, pollen from the fertile analog of the line A-344, which has the S-type of sterility, was irradiated, some single plants with fertile pollen were obtained in M_1 and M_2. In the case of the line Wf9, which has the T-type of sterility, no changes were observed after pollen irradiation. (auth)

42031 INDUCTION OF RESPIRATION-DEFICIENT MUTANTS BY ULTRAVIOLET RADIATION IN A SYNCHRONOUS YEAST CELL CULTURE. Kovacova, V.; Vlcek, D.; Miadokova, E. (Komensky Univ., Bratislava). Folia Microbiol. (Prague); 14: 554-6(1969).

Haploid cells of Saccharomyces cerevisiae in a synchronous culture were exposed in different phases of division to uv radiation lethal for 98% of the cells and the occurrence of respiration-deficient mutants among the survivors was determined. Comparison of the various phases showed significantly higher occurrence of these mutants at the onset of budding. It was concluded that the mitochondrial DNA also replicates synchronous yeast cell culture, but in a different phase from the nuclear DNA. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 41758–41760, 41763, 41776, 41796, 41856, 41858, and 41949.

42032 INACTIVATION AND REPAIR OF POLYVALENT STAPHYLOCOCCUS PHAGES AFTER U.V.- OR GAMMA-IRRADIATION OR ACRIDINE ORANGE TREATMENT. II. INFLUENCE OF THE GROWTH OF PHAGE A/5 IN VARIOUS HOSTS ON THE CHANGE OF ITS SENSITIVITY. Janovska, E.; Pillich, J.; Vizdalova, M.; Krivankova, M. (Inst. of Biophysics, Brno). Int. J. Radiat. Biol.; 16: 401-6(1969).

A study was made of the influence of the growth of polyvalent Staphylococcus phage A/5 in eight bacterial hosts on the course of inactivation of the resultant phage lysates by uv- and γ-radiation and by acridine orange. The starting titrations of all the phage stocks used were identical. The propagation of phage A/5 through various hosts affected the course of inactivation of the phage and, especially, its resistance to uv radiation was increased. Propagation of phage A/5 through host strain B1 produces its resistance both to uv- and to γ-radiation as well as to photodynamic inactivation, whereas the host strains producing the greatest sensitivity of phage A/5 to these three agents, differ in all cases. (auth)

42033 THE ROLE OF A MICROORGANISM FACTOR COMPLICATING THE COURSE OF RADIATION REACTIONS IN PATIENTS WITH MALIGNANT TUMORS. Sokolova, N. M.; Bykov, Yu. S. (Research Inst. of Oncology, Leningrad). Vop. Onkol.; 16: No. 3, 21-3(1970). (In Russian).

In patients with malignant tumors radiation therapy induced changes in species content of microflora. Pathogenic microgerms possessing hemolytic properties were found. It was demonstrated that in malignant tumors of the uterine cervix during the process of radiation therapy microgerms resistant to antibiotics appear as well as resistant forms and reduced sensitivity of isolated microgerms to antibiotics. Dysbacteriosis and bacteremia occur more rarely prior to treatment and more frequently at the end of radiation therapy. Colitis, cystitis and rectitis are most frequent radiation complications in cancer of the uterine neck, while in cancer of the lung-pulpitis and esophagitis. All

these complications were accompanied by the occurrence of various kinds of microgerms, mainly streptococci and staphylococci, showing hemolytic properties. The importance of microflora should be taken into consideration in estimating pathogenic peculiarities of the disease and corresponding complications in its radiation therapy. (auth)

42034 INCROPORATION OF 5-BROMODEOXYURIDINE INTO DNA OF WILD TYPE ESCHERICHIA COLI AND ITS USE FOR THE ENRICHMENT OF AUXOTROPHIC MUTANTS. Rosner, Arie; Yagil, Ezra (Tel-Aviv Univ., Israel). Mol. Gen. Genet.; 106: 254-62(1970).

The effect of deoxyadenosine (AdR) and 5-fluorodeoxyuridine (FUdR) on the incorporation of 5-bromodeoxyuridine (BUdR) into DNA of thymine-non requiring cells of Escherichia coli was studied. This incorporation renders the cells sensitive to irradiation at near-uv light. It was found that the combination of AdR and FUdR increases incorporation of BUdR and sensitivity to irradiation. An enrichment of auxotrophs by a factor of 10^5 was obtained from a mixed population grown in minimal medium containing BUdR, AdR and FUdR and irradiated subsequently. (auth)

42035 EFFECT OF LOW LEVEL X RADIATION ON THE ANTIGENICITY OF ESCHERICHIA COLI. Longhurst, Gerald E.; Goldner, M.; Clark, G. M. C.; Poyton, H. G. (Univ. of California, Los Angeles. Univ. of Toronto). J. Dent. Res.; 49: 795-9(Jul-Aug 1970).

The biologic effects of low-level x radiation (10 to 1,000 rads) were investigated by studying alterations in antigenicity of Escherichia coli. Antigen-antibody reactions were studied by immunodiffusion and immunoelectrophoresis to measure subtle changes to the radiation. A gradual change was observed in antigen-antibody patterns through the various levels of radiation. (auth)

42036 T-EVEN BACTERIOPHAGE-TOLERANT MUTANTS OF ESCHERICHIA COLI B. I. ISOLATION AND PRELIMINARY CHARACTERIZATION. Mathews, Christopher K. (Univ. of Arizona, Tucson). J. Virol.; 6: 163-8(Aug 1970).

A general procedure is described for isolation of T-even phage-tolerant mutants of Escherichia coli. Two such mutants of E. coli B were examined in some detail. These mutants adsorb T-even phages but are unable to release viable progeny. Under certain conditions, viability of the cells is completely unaffected by phage infection in one mutant, and there is but a slight decrease in colony-forming ability in the other. Phage deoxyribonucleic acid (DNA) is injected into these cells, as shown by the formation of phage-specific enzymes, but it is not degraded to acid-soluble material. Some phage DNA replication occurs in both strains. The mutants are both more resistant to ultraviolet light than is the parent strain. (auth)

42037 ULTRAVIOLET INACTIVATION DICHROIC RATIO OF ORIENTED fd BACTERIOPHAGE. Cram, L. S.; Deering, R. A. (Pennsylvania State Univ., University Park). Biophys. J.; 10: 413-22(May 1970).

Polarized uv irradiation of flow-oriented fd bacteriophage indicates that the degree of damage (inactivation) depends on the relative orientation of the light polarization vector and the plane of the DNA bases. The technique of anisotropic uv inactivation was evaluated, and further information on the orientation in this virus was gained. The fd bacteriophage were aligned and irradiated with plane-polarized monochromatic uv light either parallel or perpendicular to the virus axis. Variation of the inactivation dichroic ratio with wavelength implicated virus inactivation by light absorbed in both the DNA and protein. Analysis of the wavelength variation of inactivation dichroic ratios gave molecular dichroic ratios of 0.76 and 1.48 for the DNA and protein components, respectively. On the basis of these anisotropic inactivation studies, the average angle of DNA base tilt in fd was calculated to be 29 to 32°, a value in agreement with the absorption dichroism studies of Bendet and Mayfield. (auth)

42038 MUTUAL GROWTH OF ARTHROBACTER GLOBIFORMIS AND PSEUDOMONAS FLUORESCENS IN GAMMA-STERILIZED SOIL. Salonius, P. O.; Robinson, J. B.; Chase, F. E. Plant Soil; 32: 316-26(1970).

Arthrobacter globiformis and Pseudomonas fluorescens were grown separately and together in flasks containing soil sterilized by γ irradiation. If the soil was held at 60% of its waterholding capacity (W.H.C.) and 25°C, the viable cell yield of the two organisms in pure culture was approximately equal in 4 days, while in mixed culture neither organism predominated and the total yield was about the same as in either pure culture. The pseudomonad dominated the mixed cultures when the incubation temperature was 10°C, when the soil was saturated, and when glucose was added to the soil. The arthrobacter dominated the mixed culture when soil moisture was decreased to 40% W.H.C. The 10-day oxygen uptake by the two organisms grown together in sterile soil was much less than that shown by an inoculum prepared from a soil dilution. A. globiformis took up less oxygen when grown in the sterile soil than did P. fluorescens. In these short-term experiments, A. globiformis did not demonstrate competitive capabilities that would explain its more frequent occurrence in unamended soil than P. fluorescens. (auth)

42039 CHROMOSOMAL LOCATION AND PROPERTIES OF RADIATION SENSITIVITY MUTATIONS IN BACILLUS SUBTILIS. Hoch, James A.; Anagnostopoulos, C. (CNRS, Gif-sur-Yvette, France). J. Bacteriol.; 103: 295-301(Aug 1970).

Transformation and transduction crosses involving recA1, recB2, and urv-1 mutations have shown that these mutations belong to three distinct unlinked genetic loci. The precise position of these loci on the Bacillus subtilis chromosome map was determined. The behavior of recB2 strains in transformation studies suggested a dominance of $recB2^+$ function over recB2 and an early expression of this phenotype during transformation. Strains bearing two uv sensitivity markers possess a phenotype characteristic of the marker with the most adverse effect on recombination. The possibility that the effects of the two mutations are additive was also considered. Results are also presented that show that a phage-induced enzyme is not responsible for the high transducibility of recA1 strains. (auth)

42040 GENETIC ANALYSIS OF A LARGE-CELL, RADIATION-RESISTANT STRAIN OF ESCHERICHIA COLI. Kvetkas, Marilyn J.; Krisch, Robert E.; Zelle, Max R. (Argonne National Lab., Ill.). J. Bacteriol.; 103: 393-9(Aug 1970).

A genetic analysis of Escherichia coli P6, a large-cell, radiation-resistant strain of E. coli, established that it originated as the result of a mutational event. The gene responsible for the complex P6 phenotype was located at 61 ± 0.5 min on the E. coli linkage map. The close resemblance of conjugal and transductional recombinants to one or the other parent without indication of an intermediate class suggests that only a single gene may be involved. (auth)

42041 RELATIONSHIP BETWEEN RADIATION RESPONSE AND THE DEOXYRIBONUCLEIC ACID REPLICATION CYCLE IN BACTERIA: DEPENDENCE ON THE EXCISION-REPAIR SYSTEM. Billen, Daniel; Bruns, Laura (Univ. of Florida, Gainesville). J. Bacteriol.; 103: 400-3(Aug 1970).

Prestarvation of Escherichia coli for required amino acids results in a marked enhancement in both ultraviolet light (uv) and x-ray resistance for selective strains. Preventing protein synthesis by starvation for required amino acids results in completion of the cycle of chromosomal replication then underway. The relation between starvation-induced resistance enhancement (SIRE) and the excision-repair (Hcr) system in several E. coli strains including E. coli B/r hcr^+ and its isogenic mutant E. coli B/r hcr^- was investigated. The following observations were made. The Hcr system is the major component of SIRE in uv-irradiated strain B/r. By using the Hcr^+ strain, SIRE increases the 10% survival dose from about 400 ergs to about 1,200 ergs/mm². With the Hcr cells, the increase is from about 45 ergs to 60 ergs/mm². Although prestarvation leads to a moderate enhancement of resistance to x irradiation, this effect is not dependent on the Hcr system. The double mutant, E. coli B_{s-1} (hcr^- exr^-) is completely unable to express SIRE whether studied with uv or x irradiation. It is concluded that the Hcr system is the major system responsible for SIRE in uv-treated cells, whereas Exr (resistance to x rays) may be involved to a minor extent. The Exr character appears to be required for SIRE expression in x-ray exposed cells. (auth)

42042 RELATIONSHIP OF DIPICOLINIC ACID CONTENT IN SPORES OF BACILLUS CEREUS T TO ULTRAVIOLET AND GAMMA RADIATION RESISTANCE. Berg, P. E.; Grecz, N. (Illinois Inst. of Tech., Chicago). J. Bacteriol.; 103: 517-19 (Aug 1970).

Spores of Bacillus cereus T lacking dipicolinic acid showed a statistically significant reduction in resistance to uv and γ radiation as compared with spores with high dipicolinic acid content. (auth)

Radiosterilization and Radiopreservation

42043 IRRADIATION OF PACKAGED ENGLISH SOLE FILLETS. Chung, Jong Rak (Korea Inst. of Science and Tech., Seoul). J. Korean Nucl. Soc.; 1: 17-22(Sep 1969).

English sole (Parophrys vetulus) fillets packaged in polymylar bags were irradiated at 500 kRad, using a ^{60}Co irradiator and the accumulation of spoilage indices substances and bacterial growth in the irradiated and unirradiated samples was measured during 36 days of storage at 0 to 2°C. A casein-agar plate technique was developed for a direct enumeration of proteolytic bacterial population, thus enabling the determination of relative proportion of proteolytic bacteria in the total microflora at each storage interval. Irradiation at 500 kRad resulted in a ten-fold reduction of microflora and throughout the storage period the level of microflora lagged behind that of the unirradiated, by as much as one thousand fold. This was accompanied by a remarkable suppression of TVB and TMA accumulation in the irradiated samples, never reaching a spoilage level. Proteolytic bacterial population also was reduced to below 1% of the total viable count and remained so throughout the storage period, while proteolytic bacteria in the unirradiated samples increased proportionately with the storage, comprising 85.5% of the total microflora by the twenty-second day. This selective removal of proteolytic bacteria must account for the reduced rate of proteolysis that occurred in the irradiated samples during storage. (auth)

42044 RADIATION PRESERVATION OF FISHERY PRODUCTS. II. APPLICATION OF RADIATION PRESERVATION TO CURE SHRIMP, COMMON SQUID, AND LITTLE SQUID. Choe, Sang; Chung, Tai Wha; Kwak, Hi-sang (Korea Inst. of Science and Tech., Seoul). J. Korean Nucl. Soc.; 1: 23-31(Sep 1969).

Whole cure shrimp, eviscerated common squid, and little squid meats were γ-irradiated using varying doses up to one MRad. Changes in quality were assessed by organoleptic, chemical (VRS and TMA-N), biochemical (hypoxanthine), and microbiological tests; and the effect of radiation on prolonging of the storage life at 2 to 4°C was studied. With the cure shrimp, 0.12 to 0.20 MRad appeared to be optimal with 8 days of storage life, whereas the unirradiated control samples had a storage life of 3 days. With the common squid meat, 0.20 to 0.30 MRad appeared to be optimal with 14 to 21 days of storage life, whereas the unirradiated control samples had a storage life of 8 days. And for the little squid meat, 0.12 to 0.20 MRad appeared to be optimal with 10 days of storage, whereas the unirradiated control samples had a storage life of 5 to 6 days. (auth)

42045 MATING FREQUENCY AND INSEMINATING CAPACITY OF RADIATION-STERILIZED AND NORMAL MALES OF THE OLIVE FRUIT FLY. Tsiropoulos, G. J.; Tzanakakis, M. E. (Democritus Nuclear Research Center, Athens). Ann. Entomol. Soc. Amer.; 63: 1007-10(Jul 1970).

Young male Dacus oleae (Gmelin) (Diptera: Tephritidae) treated as advanced pupae with 8000 Rad of γ rays were offered virgin females daily for 30 days. Some of the treated and nontreated (control) males mated normally every day for 30 consecutive days. The majority mated every 2nd day or oftener till they died. No marked differences in mating frequency and willingness were observed between treated and nontreated flies. Nontreated males conveyed sperm to all their mating partners to the 30th mating then were found with testes of normal size and full of sperm. Treated males conveyed sperm only to the 5th to 11th mating (11th to 17th day of age), and were found with smaller testes, devoid of sperm. A comparison of irradiated males mating every 1 or every 3 days indicated that the sperm stock was exhausted after a given number of matings rather than a given age of the male. (auth)

42046 USE OF RADIOISOTOPES AND IONIZING RADIATION IN THE FOOD INDUSTRY. Holeckova, Libuse; Bartonicek, Frantisek; Cekalova, Bozena (Food Industry Research Inst., Prague). Prum. Potravin; 19: 388-9(Aug 1968). (In Czech).

As early as 1961 the Czechoslovakian food industry considered radiation pasteurization and sterilization of meat and meat products and pasteurization of beer. Since 1966, radiation processing of meat was under study, using a ^{60}Co source and doses of 100 to 600 krads at a rate of 0.5 Mrad/hr. Efforts were also devoted to selection of wrappings for radiation-processed food and included the use of radiation in combination with heat. Activation analysis for determining elements in foods was also used. In 1967, the use of tracers for studying metabolic processes in fermentative microorganisms, e.g., Aspergilus niger, was started. (TTT)

42047 CIRCADIAN SENSITIVITY AND DOSAGE-RATE RESPONSE TO X-IRRADIATION IN THE PINK BOLLWORM. Haverty, Michael I.; Ware, George W. (Univ. of Arizona, Tucson). J. Econ. Entomol.; 63: 1296-1300(Aug 1970).

A laboratory culture of Pectinophora gossypiella (Saunders) was entrained on a photo-period of LD 14 : 10. Lights-on occurred at 0530 hours and lights-off at 1930 hours. At 3-hr intervals, beginning at 2400 hours throughout a 24-hr period, male and female moths were x-irradiated with 25 kR delivered at 1.0 kR per min. In a separate study, male and female moths were x-irradiated at 1500 hours with 25 kR at four different dose rates. A highly significant difference was observed between sexes of moths, time of x irradiation, and dosage rates. Female moths at all times were less sensitive to x irradiation than males, as measured by mean longevity. The time of minimum sensitivity to x irradiation in both sexes occurred at 0600 hours, ½ hr after lights-on. Maximum sensitivity in both sexes occurred at 1200 hours, 1.5 hr after lights-off. It appeared that sensitivity to x irradiation was correlated to moth activity. As the dose rate of x irradiation was increased, the biologic damage also increased, expressed as reduced longevity. At lower dose rates, moths were able to recover and apparently repair radiation damage. (auth)

42048 PRESERVATION OF POTATOES BY IONIZING RADIATION. Penau, Henry. Bull. Acad. Nat. Med. (Paris); 153: 242-8(1969). (In French).

The comprehensiveness of the bibliographic studies and consultation with competent authorities leading to the resolution on preservation of potatoes by ionizing radiation is emphasized. The resolution permitted only a five-year authorization because of uncertainties still existing on the metabolic and chemical modifications in irradiated potatoes. The arguments on the resolution are presented. (J.S.R.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Corrosion and Erosion

Refer also to abstracts 41610, 43687, and 43729.

42049 (APDA-254) STUDIES OF MATERIAL WASTAGE RESULTING FROM REACTIONS OF WATER IN SODIUM. Chamberlain, H. V.; Cameron, J. A.; Coleman, J. H.; Deora, M. K.; Ford, J. A.; Iguchi, T.; Kovac, L. R.; Reicks, G. H.; Wooton, J. (Atomic Power Development Associates, Inc., Detroit, Mich.). Jun 1970. Contract AT(11-1)-865. 249p. Dep. CFSTI.

A program was conducted to establish a means of estimating the extent of tube wastage resulting from a small leak of water into sodium in sodium-heated steam generators, and to determine the dominant parameters affecting tube wastage. Although the program was primarily oriented to engineering aspects, it also included basic studies conducted to help determine the mechanisms of wastage during these small leaks. Descriptions are given of the test rigs used in the experimental studies. The various factors affecting material wastage rates are discussed. Comparison of the wastage data generated in this program is made with that of other investigators. Recommendations are given for the future development of additional data. (auth)

42050 (CONF-700324-1) CORROSION OF ADVANCED STEAM GENERATOR ALLOY WELDMENTS IN 1100 AND 1200 F (595 AND 650 C) STEAM. Hammond, Joseph P.; Patriarca, P.; Slaughter, G. M.; Maxwell, W. A. (Southern Nuclear Engineering, Inc., Dunedin, Fla.). [1968]. 15p. Dep. CFSTI.

From 26th Annual National Association of Corrosion Engineers, Philadelphia, Pa.

Dissimilar metal welds were studied in a steam corrosion program to join base metals having good high temperature properties (i.e., Inconel 625, Hastelloy X, and IN-102) with Incoloy 800, a material having attractive intermediate temperature properties. Welds of Incoloy 800 to 2¼ Cr-1 Mo low alloy steel (a conventional material for lower temperature service) are included. For comparative purposes, welds of Inconel 600 and austenitic stainless steel also were tested. Recommended welding filler metals for each materials combination to be tested were used throughout. Resulting data and recommendations are included. (J.R.D.)

42051 (COO-1319-82) A STUDY OF THE MECHANISM OF STRESS CORROSION CRACKING IN THE IRON-NICKEL-CHROMIUM ALLOY SYSTEM. Final Report, June 1963-June 1969. Staehle, R. W. (Ohio State Univ. Research Foundation, Columbus). Feb 1970. Contract AT(11-1)-1319. 222p. Dep. CFSTI.

The final report of a program to investigate the stress corrosion cracking (SCC) of Fe-Cr-Ni alloys in chloride environments is presented. The work involved studies to determine both the direct time-to-failure data of various alloys and the mechanistic information required to understand the cracking processes. Materials used included commercial and specially prepared alloys from the Fe-Cr-Ni system. Multicomponent alloys were also prepared. Phenomenological studies were conducted in boiling $MgCl_2$ solutions and in dilute single-phase solutions up to 289°C; chloride concentrations of 0.5 to 100 ppM and oxygen concentrations of 10 to 150 ppM were used. Mechanistic studies included thin foil corrosion studies, various electrochemical investigations, and studies of physical and mechanical properties. Conclusions are presented with respect to optimum alloy concentrations and environmental control. A coherent theory for rationalizing SCC susceptibility is described. (auth)

42052 (EURFNR-753) SODIUM CORROSION TESTS ON FUEL ELEMENT CANNING STEELS IN A SODIUM-COOLED FAST BREEDER REACTOR. Borgstedt, H. U.; Frees, G.; Drechsler, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translation of report KFK-991. 22p. Dep. CFSTI.

Work performed under United States-Euratom Fast Reactor Exchange Program.

This paper was abstracted from the original language and appeared in NSA as 24: 32340.

42053 (GAMD-9280) FRICTION AND WEAR TESTS ON TOP REFLECTOR KEYED PLENUM ELEMENT MATERIALS OF THE FT. ST. VRAIN HTGR. Hedgecock, P. D. (Gulf General Atomic, Inc., San Diego, Calif.). 27 May 1969. Contract AT(04-3)-633. 17p. Dep. CFSTI.

On the Ft. St. Vrain HTGR, the top reflector keyed plenum element assemblies are located atop the core and consist of many hexagonally shaped, stainless steel precision castings nested together in such a way that differential motion from thermal expansion can be accommodated by a system of keys and grooves between castings. The resulting relative motion generates friction forces between castings, and the potential exists for galling or seizure where the friction and wear characteristics of the coupled surfaces are particularly bad. Combinations of concern include cast AISI 347 stainless steel with LC-2 chromium carbide coating rubbing upon itself, LC-2 coated AISI 347 rubbing upon Tufftrided (liquid salt bath nitrided) AISI 1020, and malcomized (nitriding process) A286 (substitute for AISI 347) rubbing upon itself. It was found in test programs that plenum elements of chromium carbide coated Type 347 stainless steel contacting nitrided AISI 1020 steel for the keys gives the lowest wear and friction. (J.R.D.)

42054 (ORNL-tr-2340) MOLTEN SALT BREEDER STUDY. ANNUAL REPORT, 1968. MATERIALS RESEARCH. Ali Khan, I. (Kernforschungsanlage, Juelich (West Germany). [Institut fuer Reaktorwerkstoffe]). Translated for Oak Ridge National Lab., Tenn., from report JUL-608-RW. 44p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 17199.

42055 (RFP-1485) X-RAY STUDY OF OXIDATION OF A TERNARY ALLOY OF U-7.5% NIOBIUM-2.5% ZIRCONIUM (MULBERRY ALLOY). Terada, Kazuji; Goad, Henry A. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 23 Jun 1970. Contract AT(29-1)-1106. 11p. Dep. CFSTI.

The x-ray diffraction study of the oxidation of Mulberry alloy is described. Experiments were performed at 150, 250, 400, 500, and 600°C in both dry and wet air, and with different surface preparation of the samples. Only UO_2 was formed at 150° and 250°C. At 400°C, U_3O_8 was also formed after induction periods ranging from one-quarter to 10 hours. U_3O_8 was formed almost immediately at 500 and 600°C. The moisture content of the oxidizing atmosphere and the surface sample pretreatment did not appear to have any effect on the results. (auth)

42056 RELEASE OF ^{85}Kr DURING THE OXIDATION AND IGNITION OF IRRADIATED URANIUM IN CARBON DIOXIDE. Hilton, D. A. (Berkeley Nuclear Labs., Eng.). J. Nucl. Mater.; 36: 61-76 (Jul 1970).

The oxidation of irradiated uranium in carbon dioxide was studied by continuously monitoring the behavior of the fission gas ^{85}Kr. In carbon dioxide between 500 and 700°C the ^{85}Kr release was directly proportional to the degree of oxidation and the extent of oxide damage although additional losses of the active gas occurred when specimens were thermally cycled through the $\alpha-\beta$ phase transition. By defining the ignition temperature as that gas temperature which produces a sudden rapid and continued release of ^{85}Kr from the specimen, it is shown that an Arrhenius type dependency exists between the ignition temperature and the macroscopic specific area. Using this relationship, which applies to samples having microscopic specific areas of ≤150 cm^2/g, the calculated activation energy (32 kcal/mole) suggests that up to ignition temperatures of at least 730°C the oxidation is controlled by O^{2-} ion diffusion across a layer of non-stoichiometric UO_2 next to the metal. (auth)

42057 STUDY OF THE STRESSES GENERATED IN ZIRCONIA FILMS DURING THE OXIDATION OF ZIRCONIUM ALLOYS. Roy, C.; Burgess, B. (Univ. of Western Ontario, London, Can.). Oxidation Metals; 2: 235-61 (Autumn 1970).

The deformation kinetics of zirconium and Zircaloy-2 strips, resulting from oxidation at 500°C in dry oxygen, were measured as a function of time. The stress distribution in the oxidized specimens was analyzed using a stress model based on the theory of elasticity and was correlated with the oxidation kinetics. The magnitude of the stress generated during oxidation differed significantly between zirconium and Zircaloy-2; while a simple linear relationship appeared to exist between the stress and the oxide thickness on zirconium, the stresses in oxides on Zircaloy-2 increased very rapidly and discontinuously to a maximum at a film thickness near the transition in the kinetic curve. In order to characterize the stress distribution in the oxide film, vacuum annealing experiments were performed on preoxidized specimens. These indicated that the stress relaxation which occurs

during vacuum annealing resulted from dissolution in the metal of the highly stressed inner layers of the oxide film. Although these measurements have provided valuable information on the stresses generated during the oxidation of zirconium and Zircaloy-2, they do not require a causal relationship between the stresses and any oxidation process (e. g., transition). (auth)

42058 MASS TRANSFER EFFECTS IN A STAINLESS STEEL–LIQUID-LITHIUM URANIUM CARBIDE SYSTEM. Slatter, D. De L. (Atomic Energy Board, Pretoria); Howat, D. D. J. Iron Steel Inst. (London); 208: 282-8(Mar 1970).

Compatibility tests were carried out with molten lithium and uranium carbide pellets of various carbon contents contained in stainless steel capsules. Tests were conducted at temperatures of 500, 700, and 900°C for periods up to 400 hours. Results showed the stainless steel to undergo attack by the lithium, resulting initially in intergranular penetration, which was correlated with the chromium-depletion theory of intercrystalline attack, in conjunction with the temperature dependence and kinetics of nickel dissolution in lithium. At 900°C general dissolution of the stainless steel occurred and mass transfer of iron and chromium took place, chrome–iron crystals growing on the uranium carbide surfaces. A mechanism for this mass transfer is proposed postulating the presence of Li_3N as the agent in promoting the dissolution and movement of these elements. The existence of carbon activity gradients in the systems resulted in mass transfer of carbon from stoichiometric and hyperstoichiometric uranium carbides to the stainless steel. Li_3N is postulated as being important in releasing carbon from uranium monocarbide by forming U(C,N) mixtures. Attack on stainless steel, mass transfer of iron and chromium, and release of carbon from uranium monocarbide could probably be reduced or eliminated by excluding nitrogen from these systems. (auth) (UK)

42059 RULES OF THE PROCESS OF OXIDATION OF THE ALLOYS Ni_3Al–Ni_3Nb. Arbuzov, M. P.; Chuprina, V. G. (Inst. of Problems of Science of Materials, Kiev). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 12, 75-83(1969). (In Russian).

The oxidation of the alloys Ni_3Al and Ni_3Nb occurs as the result of the diffusion of oxygen ions at the alloy interface due to the relatively thick internal layer of complex composition and the diffusion of nickel ions at the gas interface which results in a thin external layer of NiO. Protective binary oxides of NiO–Nb_2O_5 (at temperatures from 700 to 725°C) and NiO–Al_2O_3 (at 800 to 850°C) were formed. Moreover, a conversion of alpha to beta Nb_2O_5 took place at 825 to 900°C which resulted in a considerable reduction in alloy oxidation. (tr-auth)

42060 INFLUENCE OF THE β–α-TRANSFORMATION AND THE ZrV_2-PRECIPITATION ON THE CORROSION BEHAVIOUR OF Zr–V ALLOYS IN SATURATED STEAM. Borchers, H.; Wagner, G. (Technische Hochschule, Munich). Werkst. Korros.; 20: 941-9(Nov 1969). (In German).

Using a light microscope, measurements of hardness and weight gain were made in studies of the effects of ultrastructure on corrosion behavior of zirconium–vanadium alloys. Because of similarity of behavior between zirconium and transition metals in alloy systems, the results are generally valid. From the results, conclusions were drawn about the effects of precipitated secondary phases, the mechanisms of oxide formation, and breakaway. A procedure is outlined for optimizing corrosion and hardness behavior through suitable ultrastructure formation. (tr-auth)

Preparation and Fabrication

Refer also to abstracts 41588 and 41611.

42061 (DP-Report-246(Pt.1)) ELECTRON BEAM WELDING EXPERIMENTS FOR HIGH TEMPERATURE THERMOCOUPLE SHEATHS. PART I. Project DRAGON. Hansen, R. A. (Atomic Energy Establishment, Winfrith (England)). Nov 1963. 22p. Dep. CFSTI.

Experiments conducted in a program to develop thermocouples suitable for measuring maximum temperature in Dragon fuel elements are described. Methods joining the Mo sheath to stainless steel by use of a direct weld with overlap or by use of a sleeve weld are described as most successful. The sheath hot end is closed by melting a metal plug into it. (J.R.D.)

42062 (DP-Report-247) ELECTRON BEAM WELDING EXPERIMENTS FOR BURSTING DISC ASSEMBLIES. PART II. Project DRAGON. Hansen, R. (Atomic Energy Establishment, Winfrith (England)). Dec 1963. 17p. Dep. CFSTI.

Results of tests to determine if 0.0005-in. Ni disks can be welded to Monel 400 holders for bursting disk assemblies used in the Dragon He purification plant are presented. It was found that the welds are successful. (J.R.D.)

42063 (DP-Report-396) REMOTE AUTOMATIC TABULAR WELDING DEVICES FOR 18/8/1 STAINLESS STEEL. Project DRAGON. Bateman, A. R.; Barnes, E. (Atomic Energy Establishment, Winfrith (England)). Feb 1966. 40p. Dep. CFSTI.

An outline of the method used to establish welding parameters, a description of the materials and equipment used, and an account of actual welding experience during the construction of the Dragon Reactor are included. (auth)

42064 (NP-10265) AN APPRAISAL OF ZIRCONIUM AS A BRAZING MEDIUM FOR FUEL BOXES. Project DRAGON. Burnett, R. C.; Marengo, G. (Atomic Energy Establishment, Winfrith (England)). Apr 1961. 10p. (DP-Report-27). Dep. CFSTI.

The present concept of the fuel element requires the fuel box to delay fission products from entering the fission product purge stream by at least 1 hour from their birth within the fuel particle. This requires that the graphite should have a permeability better than 10^{-8} cm^2 sec^{-1} and that the seal should be leak tight. The high operating temperature (up to 1700°C) limits possible sealing methods and of several alternatives, the zirconium braze appeared most attractive. Results of experimental work show that zirconium brazes fail under conditions resembling those expected in the Reactor Experiment. Even though it may be possible to develop techniques to minimize the failure, the results obtained are such as to suggest that zirconium, in spite of its many advantages, is an inappropriate material for brazing the fuel boxes. (J.R.D.)

42065 (NP-11063) A THREE ELECTRODE PLASMA WELDING DEVICE FOR THERMOCOUPLE HOT JUNCTIONS. Project DRAGON. Smyth, R. T.; Sturge, D. W. (Atomic Energy Establishment, Winfrith (England)). Oct 1961. 16p. (DP-Report-57). Dep. CFSTI.

Methods are described for making thermocouple hot junctions and fusion seal welding of conventional and refractory metal sheathed mineral insulated thermocouple cables, using plasma welding techniques. (auth)

42066 (RFP-1428) MACHINABILITY OF PLUTONIUM. Durbin, Charles E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 20 Jul 1970. Contract AT(29-1)-1106. 47p. Dep. CFSTI.

Experiments were undertaken to provide significant data, scarce in the literature, on the cutting processes used for machining delta plutonium. To the extent possible, the optimizing of machine parameters was considered important in obtaining the best results. Reported in detail are the various effects of tool geometry and cutting conditions. Equipment and uses are described also. Data analyses, procedures, and graphic interpretations are given as plotted data of tool force, isoforce contour, total tool force, and total isoforce contours versus various parameters. In addition, a slide rule technique with a sample rule are presented for determining tool forces, surface finishes, and removal rates. (auth)

42067 CONTINUOUS PROCESSING AND PROCESS CONTROL. Proceedings of a Symposium, Philadelphia, Pennsylvania, December 5–8, 1966. Ingraham, Thomas R. (ed.). Metallurgical Society Conferences. Volume 49. New York; Gordon and Breach, Science Publishers, Inc. (1968). 557p. $34.50. (CONF-661219).

Papers are included on progress in the development of continuous processing and process control. A variety of subjects are covered from the beneficiation of ores to the continuous casting of metals. There are 25 papers included in the conference proceedings, and separate abstracts were prepared for two of these. (B.L.M.)

For abstracts of individual papers see: 41189 and 41399.

42068 STANDARD METHODS FOR MACRO-ETCHING METALS AND ALLOYS. 2. SPECIFIC PREPARATION PROCEDURES AND RECOMMENDED SOLUTIONS (CONTINUED). Prakt. Metallog.; 7: 314-24(Jun 1970). (In English and German).

Methods are described for etching Sn and its alloys, Pb and its alloys, Mg and Ni and their alloys, noble metals, refractory metals, Ti and its alloys, Zr and its alloys, Hf and its alloys, and Zn and its alloys. (J.R.D.)

42069 DEVELOPMENT OF PERMANENT MAGNETS ON THE BASIS OF COBALT AND RARE EARTH METALS. Strnat, K. J.; Ray, A. E. (Univ. of Dayton, Ohio). Z. Metallk.; 61: 461-70 (Jun 1970). (In German).

Intermetallic phases of cobalt with several rare earth metals

can be used for the production of permanent magnets. Energy products up to 36 MGOe are theoretically possible. $SmCo_5$ magnets with more than 20 MGOe were prepared in the laboratory by means of powder metallurgy. Intrinsic coercive forces near 30 kOe were attained. The new magnets are specially suited for micro-wave tubes and other electronic applications, as well as for motors. The physical and metallurgical concepts, the metallurgical problems of the alloys, the production methods for powders and magnets, and the state of research and development are reviewed. Commercial applications of the magnets and economic factors are also discussed. (auth)

42070 GETTING THE BEST OUT OF BERYLLIUM COPPER. Dawson, R. J. Copper; 3: No. 1, 6-8(Jan 1969).

Optimum methods of aging Be–Cu alloys are discussed. It is noted that the condition of the alloy immediately prior to aging affects its final properties. Aging is usually left to the user. Guidelines for use in aging and subsequent precipitation hardening processes are presented in which properties of the final product are indicated. (J.R.D.)

42071 ELECTRON METALLOGRAPHY OF POWDER BERYLLIUM: A HOT-PRESSING MECHANISM AND THE ROLE OF OXYGEN IMPURITIES. Lindsay, H. M.; Scott, V. D. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Nucl. Mater.; 36: 29-40(Jul 1970).

The application of electron microscopy of the study of hot-pressing beryllium powder is described. Microstructural examination revealed that the principal impurity in consolidated metal was beryllium oxide which was introduced into the material as a surface layer on the original powder particles. The oxide in the compact, although distributed as a network of fine precipitates surrounding relatively precipitate-free regions, was not concentrated at the final grain boundaries. As the oxide was found to be stable in beryllium, behaving as a form of reference marker, it was deduced that this network was the remains of the oxide present on the surface of the powder particles. Clusters of very small grains were observed in material pressed at low temperatures, indicating that nucleation took place in the initial stages of compaction, the formation of nuclei being related to the highly deformed contact regions between projections on the particle surfaces. As consolidation proceeded, the grains grew and the final compact contained a grain structure superimposed on, but not directly related to, the original oxide network. It is therefore concluded that the hot-pressing process is analogous to hot-working, with definable stages of nucleation and recrystallization taking place, and that consolidation was facilitated by promotion of the bulk flow characteristics during the working. The improved strength of beryllium of powder origin, as compared with metal fabricated from cast ingot, is ascribed mainly to a finer grain size, the oxide having a beneficial effect in minimizing grain growth. It is shown that ~0.2 wt % oxygen is sufficient to maintain a thermally stable structure up to temperatures ~10°C below the melting point of beryllium, oxide levels in excess of this being of little further benefit with respect to grain size control. It is also concluded that the distribution of oxide precipitates has by no means been optimized to achieve maximum lattice hardening and since the limited solubility found for oxygen in beryllium appears to preclude the possibility of modifying the precipitate dissemination by thermal treatment, it is suggested that recycling the powder may be advantageous. (auth)

42072 URANIUM MILLING TECHNOLOGY: TRENDS IN FLOWSHEET DESIGN. Thunaes, A.; Colborne, G. F. (Eldorado Nuclear Ltd., Ottawa). Trans. Can. Inst. Mining Met.; 71: 320-5(1968).

When the Canadian uranium milling plants went into operation during the early 1950's, they utilized flowsheets developed at the Radioactivity Division of the Federal Mines Branch in Ottawa. Since then, numerous process improvements have been made by the Mines Branch, by the operating companies themselves, and by other research organizations. Uranium milling technology is considered from the standpoint of a new mine operator charged with the responsibility for the design of an economic flowsheet. The range of process elements available to him and the testwork required to enable an intelligent decision to be made are indicated. (auth)

42073 ELECTROCHEMISTRY OF MOLTEN AND SOLID ELECTROLYTES. VOLUME 8. MECHANISM AND KINETICS OF ELECTRODE PROCESSES. Pal'guev, S. F. (ed.). New York; Plenum Publishing Corp. (1970). 91p.

Translated by Halina Wroblowa from Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 11, 3-136(1968).

Fourteen papers are included, two of which have been abstracted individually for NSA. The remaining studies include reports on the theory of the diffusion potential and of the microdistribution of current at cathodes immersed in molten salts, data concerning the kinetics of anodic and cathodic processes during electrolysis of W, Zr, Hf, and Nb salts, and studies on the electrocrystallization of copper and tungsten. Studies on diffusion coating with boron and cobalt and the electrochemical kinetics of gas electrodes and corrosion of materials in carbonate melts are also included. (J.G.B.)

For abstracts of individual papers see: 42074 and 42075.

42074 DIFFUSIONAL SILICIFICATION OF MOLYBDENUM, TUNGSTEN, AND NIOBIUM IN MOLTEN SALTS. Anfinogenov, A. I.; Ilyushchenko, N. G.; Belyaeva, G. I.; Finkel'shtein, S. D. Trans. (Tr.) Inst. Electrochem., Acad. Sci. USSR, Urals Br.; 8: 51-5(1970).

Translated from Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 11 (1968).

A method was developed for the application of silicon coatings to high-melting metals in molten salts. Two compositions (wt %) of the melt were used: (1) equimolar KCl–NaCl mixture, 72; NaF, 14; Na_2SiF_6, 14, and (2) equimolar KCl–NaCl mixture, 95; Na_2SiF_6, 5. Samples were placed in an alundum crucible covered with silicon powder, then with the electrolyte. The effects of temperature, duration of process, and electrode composition were studied. Silicon coatings on Mo, W, and Nb were obtained at 800, 850, 900, and 950°C and after 3, 5, 7.5, and 10 hours. The coatings were studied using metallographic and x-ray diffraction methods. (J.G.B.)

42075 CATHODIC PROCESSES DURING DEPOSITION OF ZIRCONIUM AND HAFNIUM ON LIQUID ZINC IN CHLORIDE–FLUORIDE MELTS. Petenev, O. S.; Ivanovskii, L. E. Trans. (Tr.) Inst. Electrochem., Acad. Sci. USSR, Urals Br.; 8: 56-60 (1970).

Translated from Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 11 (1968).

Cathodic processes during deposition of zirconium and hafnium on liquid zinc from a mixture of potassium fluorozirconate and fluorohafniate dissolved in molten alkali chlorides were studied. It was found that due to depolarization accompanying alloy formation of Zr and Hf with Zn, deposition potentials at a liquid cathode are much more positive than at a solid one. In contrast to Zr deposition, that of Hf on a solid and on a liquid cathode is not accompanied by formation of insoluble compounds of lower valence. (J.G.B.)

42076 THORIA DISPERSION STRENGTHENED NICKEL ALUMINIDE AND METHOD OF MAKING. Miller, Donald G. (to General Motors Corp.). U. S. Patent 3,520,675. 14 Jul 1970. Filed 5 May 1967.

Nickel aluminide powder having submicron size particles of thorium dioxide (thoria) uniformly dispersed therein is prepared by reacting an aluminum halide compound in the vapor state with thoria dispersion strengthened nickel powder is particularly suitable for hot pressing into components requiring improved high temperature strength. (auth)

42077 ULTRA-HIGH-STRENGTH PRESSURE VESSEL. Sandstrom, Donald J.; Law, Delman A. (to United States Atomic Energy Commission). U. S. Patent 3,516,878. 23 Jun 1970. Filed 13 Jan 1967.

A prestressed lamellar pressure vessel is described wherein the prestressing is accomplished by placing a semiaustenitic precipitation hardenable stainless steel sphere within a martensitic stainless steel sphere (to close tolerances) and heat treating. (auth)

42078 METHOD OF MAKING COMBINATION FUEL RODS. Ayer, James E. (to United States Atomic Energy Commission). U. S. Patent 3,517,431. 30 Jun 1970. Filed 28 Apr 1967.

A method of making uniform close-packed dispersions in which different materials are arranged in layers within a container is described. Predetermined amounts of different materials which are of a relatively large diameter are added to the container in succession and compacted by vibration. Then, in the same order, successive amounts of material which are relatively smaller in diameter are added to the container in quantities just sufficient to occupy the spaces or interstices between the larger diameter materials of the same type, while vibrating the container. (auth)

42079 METALLOGRAPHIC PREPARATION OF TWO-PHASE TITANIUM ALLOYS FOR REPLICA ELECTRON MICROSCOPY. Fopiano, P. J.; Zani, A. J. (Army Materials and Mechanics Research Center, Watertown, Mass.). Metallography; 3: 209-13 (Jun 1970).

A technique used to prepare two-phase titanium alloys for

metallographic observation by replica electron microscopy is described in detail. The procedure is applicable to a wide variety of titanium systems. It eliminates many of the problems of electropolishing. Its advantages include simplicity, elimination of surface damage, minimizing of surface relief, and ability to polish large section sizes. (L.C.L.)

42080 DEVELOPMENT OF A PSEUDOEUTECTIC NICKEL-BASED COMPOSITE ALLOY. Shen, Yuan-shou; Griffiths, Leonard B. (P. R. Mallory and Co., Inc., Burlington, Mass.). Met. Trans.; 1: 2305-13(Aug 1970).

A detailed account of the development of a Ni–Cr–Be composite alloy is given. Its cast structure was that of a duplex eutectic with hard nickel beryllide fibers embedded in a softer Ni–Cr solid solution matrix. A partial liquidus projection of the Ni–Cr–Be system was determined in order to define the solidification conditions and optimum composition range for the alloy. Alloying with aluminum, tungsten, and molybdenum was used to enhance the mechanical properties of the material. Heat treatment conditions, mechanical properties, and oxidation behavior are presented. (auth)

42081 STUDY OF MOLYBDENUM CLEANING FROM CARBON IMPURITY BY THE SECONDARY ION EMISSION METHOD. Kolot, V. Ya.; Tatus, V. I.; Rybalko, V. F.; Fogel, Ya. M. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh.; 15: 266-8(Feb 1970). (In Russian).

The secondary ion emission method was used for studying the purification of molybdenum from carbon impurities. The purification was performed by heating a molybdenum strip in the oxygen atmosphere (strip temperature—1900°K, oxygen pressure 1.10^{-6} mm Hg). A decrease of carbon concentration in the strip was controlled by measuring intensities of beams of C^- and C_2^- secondary ions. An intensity of CO^+ and CO_2^+ gas ion beams was also measured. It was shown that after heating the strip for 6 hr the intensity of C^- and C_2^- ion beams became very small. The carbon impurity which remained after such a treatment did not influence the process of molybdenum oxidation. (auth)

42082 FABRICATION OF INSTRUMENTED FUEL ELEMENTS AND IN-PILE CAPSULES. Franco-Ferreira, E. A.; Williams, L. C. (Oak Ridge National Lab., Tenn.). Weld. J.; 49: 455-63(Jun 1970).

In-pile capsules and prototype fuel elements were designed, fabricated, and tested to obtain data regarding the fuel, cladding material, and overall operating characteristics of the fuel element. The collection of these data required the installation of comprehensive instrumentation in the capsule or fuel element. The techniques used for fabricating these units and installing some of the instrumentation are described. Testing of in-pile capsules usually preceded the design and fabrication of prototype fuel elements. A wide variety of capsules and fuel elements were built. Fuels included UO_2, UC, and $(Th/U)C_2$. The designs used for the capsules and prototype fuel elements were usually one of a kind. Since the purpose of testing these units is the evaluation of a design, the fuel, or the cladding material, there is great incentive to develop fabrication techniques which will not introduce extraneous variables into the test. Thus, the techniques described here are some of the specialized adaptations of welding and brazing which were developed to satisfy these requirements. Capsule end caps were usually installed by welding, with an edge-weld joint design being preferred, which was the most reliable and reproducible method of end closure installation. The bulk of capsule instrumentation was in the form of thermocouples for measuring the temperature of the cladding and of the center of the fuel. Special brazing techniques were devised for joining the cladding temperature thermocouple to the inside surface of the cladding. Ultrasonic inspection of these brazed joints showed them to be of high quality with little or no nonbonding detectable. Fuel central temperature was measured by refractory- or noble-metal thermocouples. These were contained in refractory-metal wells which pass through holes in the center of the fuel pellets. The refractory-metal thermocouple wells must be reliably sealed to stainless steel or other alloy end caps to prevent fission gas release. Methods of making transition joints for these dissimilar combinations were developed. Unique designs were also developed for making welded tungsten vs rhenium thermocouple junctions which would be resistant to failure due to thermal cycling. Methods used for making instrumented in-pile capsules were adapted to the production of five instrumented fuel assemblies for the Experimental Gas-Cooled Reactor. These fuel assemblies were intended to be the only in-core instrumentation in the reactor, and all reactor operation would be dependent on their functioning properly. Thus, a premium was put on the development of reliable methods of fabrication. The fabrication of refractory-metal in-pile capsules poses some special problems due to the high melting points of the materials used and the high temperatures experienced during operation. Special, high-melting-point, refractory-metal-base brazing alloys were used in building these capsules. The adaptation of electron beam brazing to their manufacture is also described. (auth)

42083 PURIFICATION OF BERYLLIUM BY LIQUID–LIQUID EXTRACTION. Seeley, Forest G.; Crouse, David J. Jr. (to United States Atomic Energy Commission). U. S. Patent 3,518,063. 30 Jun 1970. Filed 3 Oct 1967.

A method of separating Be values from extraneous impurities comprises selectively extracting Be values from an aqueous alkaline carbonate solution with an organic solution of a quaternary ammonium carbonate containing 39 to 75 carbon atoms and having at least one methyl group attached to each nitrogen atom. The extraction as well as the associated scrubbing and stripping steps are all carried out in an alkaline system. The Be produced by this method is sufficiently pure for use in nuclear applications. (B.L.M.)

42084 PREPARATION AND PURIFICATION OF CRYSTALLINE BORON. Savitski, Michael J. (to United States Atomic Energy Commission). U. S. Patent 3,520,482. 14 Jul 1970. Filed 11 Sep 1968.

A process for producing crystalline boron comprises milling contaminated amorphous boron into a particulate mixture, segregating a density fraction having a higher boron purity than the aggregate, pelletizing such particulate density fraction, sintering the pellets to vaporize peripheral impurities while concentrating residual impurities to the pellet core, crushing the cooled pellets until about half of them passes through a fine mesh screen, and recovering the high purity fraction, which remains on the screen. (auth)

42085 PRINCIPLES AND TECHNIQUES OF ULTRASONIC WELDING AND ITS APPLICATION IN NUCLEAR TECHNOLOGY. Zuern, Herbert (Indian Inst. of Tech., Madras); Richter, Helmut. Z. Schweisstech.; 58: No. 3, 65-75(Mar 1969). (In German and French).

Experiences with ultrasonic welding are reviewed. Historical development and general applications are discussed as well as specific utilization in reactor techniques. The method is useful because most metals can be welded to themselves or to others, no excess heating is required, no electric current passes through the material so that spraying is avoided, the equipment is easily handled permitting employment of untrained workers, and protective glasses are not required. 40 references are given. (H.B.G.)

42086 REFRACTORY AND CERAMIC BRAZING ALLOYS. Canonico, Domenic A.; Bryson, Lloyd G.; Slaughter, Gerald M. (to United States Atomic Energy Commission). U. S. Patent 3,515,545. 2 Jun 1970. Filed 29 Sep 1967.

The invention relates to a class of brazing alloys having particular utility for brazing parts of (a) a refractory metal selected from the group consisting of Ta, Mo, Ti, and Nb, and their alloys, and (b) ceramics such as Al_2O_3, BeO_2 and TiO_2 to themselves and to each other. The brazing alloy containing equal parts, by weight of Ti and Zr and a ternary metal additive selected from the group consisting of Ta, Si, Ge, Cr, B, and Nb, the ternary addition being in such amounts as to form a ternary alloy whose melting point is at or below the melting point of the binary Ti–Zr alloy. (auth)

42087 WELDING PERFORMED FOR THE D_2O CRITICAL ASSEMBLY. 2. Sato, Masayuki (Oarai Engineering Center, Japan); Miyoshi, Shigeru; Nakanishi, Tsuneo; Sakamoto, Yoshihiko. Keikinzoku Yosetsu; No. 86, 49-56(Feb 1970). (In Japanese).

Blow holes and inter-granular cracks occurring in aluminum welds, and the countermeasures for these flaws are reported. In the preliminary test welds, blow holes were formed, which were removed in the welding of tank panels by careful cleaning of the edges, the reduction of the number of passes, sufficient gas shield, and temperature control. The x-ray penetration examination of blow holes and cracks in the aluminum weld are reviewed along with the problems involved in the x-ray photography of aluminum. The effects of insufficient penetration in welding on the fatigue strength of aluminum fillet welds are discussed. The cracks along grain boundaries from the tip of the position of insufficient penetration were observed and the effects on the weld fatigue-strength were studied. (Japan)

42088 WELDING PERFORMED FOR THE D_2O CRITICAL ASSEMBLY. 1. Sato, Masayuki (Oarai Engineering Center, Japan); Miyoshi, Shigeru; Nakanishi, Tsuneo; Sakamoto, Yoshihiko. Keikinzoku Yosetsu; No. 85, 2-8(Jan 1970). (In Japanese).

The D_2O Critical Assembly (DCA) was constructed for the de-

velopment of an advanced thermal reactor (ATR). The ATR is a D_2O moderated, boiling light-water cooled reactor. The purpose of DCA is to provide the necessary information about nuclear characteristics and safety in fuel cycles. The main structural material of DCA is corrosion-resisting aluminum, ALCOA 5052; it is used for the core tank, fuel cladding, and other components. The reason for using aluminum is discussed along with construction of the DCA, including a core tank and a core structure. Welding for the DCA, including the selection of a welding method, the pre-treatment of the welded parts, and welding for the core tank, grid, and calandria tubes is also discussed. (Japan)

42089 PREPARATION OF THICK CHROMIUM TARGETS BY ELECTROPLATING. Akiba, Fumimasa (Hirosaki Univ., Japan); Murakami, Yukio. Nippon Genshiryoku Gakkaishi; 12: 382-5 (Jul 1970). (In Japanese).

A method is described of preparing Cr foils as thick as 20 to 50 mg/cm^2, to be used as targets in the production of ^{52}Fe. The Cr was electroplated from an electrolyte solution (300 g/l CrO_3, 2.0 g/l H_2SO_4 of s.g., 7.0 g/l Na_2SiF_6) on a pure Cu sheet and then the Cu was removed by dissolution in (1:1) HNO_3. Free Cr foil thus obtained was soaked in a 1:1 mixture of 20% NH_4OH and 10% $(NH_4)_2S_2O_3$ for 30 min. After the foil was washed with water, it was heated at 120 to 150°C. For the electroplating, a cell with Pt anode and Cu sheet cathode was made of Lucite (cell (a)) and of glass (cell (b)), with deposition areas of 2.54 cm^2 and 7.07 cm^2, respectively. Direct current (6V) was supplied by a storage battery. For the preparation of enriched ^{50}Cr targets, the electrolysis conditions were studied in detail. Using cell (a), the electrolysis could be performed without rotating the anode, at 275 mA/cm^2 with an average current efficiency of ~20%, after striking at 2A (787 mA/cm^2) for 40 to 60 sec. After 4 hr a foil of 60 mg/cm^2 thickness was obtained from 3 ~ 5 ml of the electrolyte solution with a deposition yield of 32%. For the preparation of natural Cr target with use of cell (b), the striking was at 3.0 to 2.5A for 40 ~ 60 sec, and the electroplating was continued for 90 to 120 min at 250 ~ 300 mA/cm^2 while rotating the anode, resulting in foils of 20 ~ 40 mg/cm^2 thickness and 30 mm in diameter. (auth)

Properties Evaluations

Refer also to abstracts 41256, 41580, 41583, 41597, 41609, and 42823.

42090 (CEA-CONF-1562) VAPORIZING OF URANIUM AFTER SHOCK LOADING. de Beaumont, P. (Commissariat a l'Energie Atomique, Paris (France)). 1970. 10p. (In French). (CONF-700803-6). Dep. CFSTI (U. S. Sales Only).

From 5th Symposium on Detonation, Pasadena, Calif.

An explosive device using the conical implosion principle was used to induce, in uranium and copper pellets, flat high-intensity shock waves, reaching up to 15 Mb in uranium. The shock speed and the free surface velocity were determined experimentally. Various equations of state were used to interpret the results obtained in uranium; only a liquid-type equation can reproduce both these results and those obtained earlier up to 2 Mb. It is concluded in particular that the free surface velocities observed for a 15 Mb shock in uranium imply a complete vaporization of the metal during the expansion. (auth) (France)

42091 (COO-841-20) DIFFUSION STUDIES IN LIQUID METALS. Progress Report, June 16, 1969-June 15, 1970. Swalin, R. A. (Minnesota Univ., Minneapolis. Inst. of Tech.). Jun 1970. Contract AT(11-1)-841. 15p. Dep. CFSTI.

Research progress is reported on thermotransport in liquid Ag, self-diffusion in liquid In and Hg, and radial distribution functions of liquid K. (J.R.D.)

42092 (COO-1198-683) SUPERPLASTIC DEFORMATION IN A EUTECTIC ALLOY OF CADMIUM AND ZINC. Merriman, Edmund Alan (Illinois Univ., Urbana). Feb 1970. Contract AT(11-1)-1198. 110p. Dep. CFSTI.

Thesis.

Results of investigations conducted to determine what mechanisms operate to produce superplasticity in Cd-2n eutectics are presented. Analyses of the results lead to the conclusion that grain boundary sliding is the predominant mechanism of superplastic deformation in these eutectic alloys, and theoretical calculation results suggest that grain boundary diffusion creep may contribute to the deformation as well. The activation energy measurements indicate that prismatic slip controls the superplastic deformation rate at temperatures above about 215°C (0.91 Tm), probably by acting to accommodate grain boundary sliding. A Peierls stress-controlled glide mechanism proposed by Weertman and modified for superplastic conditions can adequately explain the observed dependence of the strain rate on stress and grain size at high temperatures. At temperatures from 150 to 215°C (0.78 to 0.91 Tm), glide of dislocations which drag Zn atmospheres seems most likely to control the strain rate. It is proposed that as strain rate decreases to very low values in fine grained Cd-Zn, dislocations are no longer annihilated at the nearby grain boundaries, but instead climb and are annihilated within the grain. The resulting stress dependence of the dislocation array length causes the observed decrease in the strain rate sensitivity of the flow stress. This proposal could be applied to other superplastic alloys as well, to attempt to explain the generally observed low m at low strain rates. (J.R.D.)

42093 (CU-2660-56) HIGH TEMPERATURE SATURATED PHASE DENSITIES AND THE CRITICAL DENSITY AND TEMPERATURE OF CESIUM. Oster, George F.; Bonilla, Charles F. (Columbia Univ., New York. Liquid Metals Research Lab.). [1970]. 7p. (CU-2660-43; CONF-700901-1). Dep. CFSTI.

From 5th Symposium on Thermophysical Properties, American Society of Mechanical Engineers, Boston, Mass.

A new method for determining the high temperature saturated liquid and vapor phase densities and the critical density and temperature of a substance was devised. A cylindrical capsule partially filled with the substance is suspended from transverse mid-length off-center knife edges, and its rest angle measured at various temperatures, up to horizontality. The rest angle is a function of the phase densities, and can be solved simultaneously with the rest angle from another one or more capsules containing different masses of the substance, or with any other relation between the two phase densities at the same temperature. When applied to cesium, the critical temperature was obtained as 3227°F and the critical density as 0.407 g/cc. However, by an independent method, 3235°F was subsequently obtained for the critical temperature and the average, 3231°F, is recommended as the critical temperature of cesium, with 0.406 g/cc as the corresponding critical density. (auth)

42094 (DP-Report-287) THE PROBLEM OF WELD CRACKING IN MACHINE WELDS IN AUSTENITIC STAINLESS STEEL VALVES. PART I. THE METALLURGICAL EXAMINATION OF A MACHINE WELDED SEAL PLUG TO VALVE BODY JOINT WHICH CONTAINED CRACKS. PART II. THE NON-DESTRUCTIVE EXAMINATION OF AUSTENITIC STAINLESS STEEL COMPONENTS TO DETERMINE THE PRESENCE OF FERRITE. Project DRAGON. Conde, J. F. G.; Holliday, J.; Hobbs, J. (Atomic Energy Establishment, Winfrith (England)). Jun 1964. 44p. Dep. CFSTI.

The metallurgical examination of a cracked seal plug/body weld taken from a machine welded valve assembly is described. The cracking is attributed to hot cracking associated with fully austenitic weld metal in the presence of restraint. Remedial measures are described together with details and results of weld procedure tests carried out to demonstrate the efficacy of the measures proposed. The probable constitution of weld metal arising from fusion welds between those mating components still remaining to be welded is predicted from a consideration of equivalent nickel and chromium values based on chemical analysis. It was concluded that these theoretical predictions should be substantiated by magnetic measurements of the ferrite content of the parent materials and that, in future, specifications for materials for similar applications should lay down requirements for ferrite content in order to prevent the use of fully austenitic qualities of steel. To this end empirical rules based on those of Schaeffler are proposed. The non-destructive procedure adopted for assessing the presence of ferrite in components remaining to be welded are described, and the results of tests which were made are presented. The results support the conclusions reached in Part I. (auth)

42095 (GEMP-745) FAST BREEDER REACTOR ADVANCED FUEL ELEMENT CLADDING FABRICATION. Termination Report (1115) Covering the Period, July 1, 1969-August 31, 1969. Frank, R. G.; Tarr, C. O. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Aug 1970. Contract AT-(40-1)-2847. 48p. Dep. CFSTI.

Commercially available cold worked and stress relieved molybdenum was found to have low tensile ductility (~3%) over the expected service temperature range of the LMFBR, 550 to 750°C. This is in contrast to 35 to 45% elongation for recrystallized molybdenum. Thermal-mechanical processing studies were conducted to identify a processing sequence that would result in an optimum combination of strength and ductility in the temperature range of 550 to 750°C. Although the study was not complete at the termination of the program, it was found that a well worked structure in combination with a high stress relief temperature (955°C) results in tensile elongation in excess of 10% at 650°C. It appears

that completion of the present work at ORNL will suffice to identify the optimum thermal mechanical treatment to develop the desired ductility for unalloyed molybdenum in the range of 550 to 750°C. However, because of the termination of the program, it was not possible to thoroughly analyze the data and to correlate changes in properties with microstructure and texture of the final product. This remains to be done. Similar studies with ultra-high purity molybdenum are recommended in order to determine the influence of carbon and oxygen on the mechanical properties in the range of 550 to 750°C. (J.R.D.)

42096 (ORNL–4561) INFLUENCE OF TITANIUM ON THE HIGH-TEMPERATURE DEFORMATION AND FRACTURE BEHAVIOR OF SOME NICKEL BASED ALLOYS. Sessions, Charles Edward (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 189p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

An investigation of the influence of titanium on the deformation and fracture behavior of nickel and a nickel base alloy, Hastelloy-N (Ni-12% Mo-7% Cr-0.07%C) was conducted. The purpose was to relate the influence of titanium on the precipitate types, morphology, and distribution to the elevated temperature mechanical behavior in creep and tensile tests. Experimental results indicate that titanium influences the mechanical behavior in Hastelloy N and in pure nickel in two significantly different ways. In the case of Hastelloy N grain boundary shearing is reduced owing to the influence of different carbide types and distributions, and in the case of the Ni–Ti alloys enhanced grain boundary mobility is responsible for the enhanced hot ductility when titanium is added. (J.R.D.)

42097 (ORNL-TM-1312(Vol.8)) STRUCTURAL ANALYSIS OF SHIPPING CASKS. VOL. 8. EXPERIMENTAL STUDY OF THE STRESS-STRAIN PROPERTIES OF LEAD UNDER SPECIFIED IMPACT CONDITIONS. Evans, J. H. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 105p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

Results of an investigation to determine the stress-strain properties of lead subjected to gross compressive strains at strain rates comparable to those experienced by lead shielding in shipping containers for radioactive materials under accident conditions are presented. Right circular cylinders of chemical lead with five different geometries were impacted by free-falling steel cylinders of three different weights dropped from various heights. The force was measured and recorded as a function of time by using a resistance-strain-gage load cell, amplifier, oscilloscope, and a Polaroid camera. A computer program was written to numerically integrate the force-with-respect-to-time data to obtain velocity-with-respect-to-time and displacement-with-respect-to-time data. From these data, a stress-strain curve was plotted and an approximate equation for this curve was written. It was found that the empirical equation described the dynamic true stress-strain curve for chemical lead and that the curve for this equation demonstrated reasonable agreement with the experimental data at strains up to 0.5 inch per inch. It was concluded that the dynamic stress-strain relationship for chemical lead expressed by this equation can be applied in actual design problems with approximately the same accuracy as is normally encountered when published material property data are used. (auth)

42098 (SC-T-70-4025) HIGH-TEMPERATURE SOLUBILITY OF NITROGEN IN TUNGSTEN. Fromm, E.; Jehn, H. Translated by T. Watt for Sandia Labs., Albuquerque, N. Mex., from J. Less-Common Metals; 17: 124-6(1969). 7p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 8182.

42099 (UCRL–72223) DELTA AND EPSILON THERMAL EXPANSION COEFFICIENTS AND THE DELTA-TO-EPSILON CONTRACTION FOR SOME PLUTONIUM-RICH ALLOYS. Goldberg, Alfred; Rose, Robert L. (California Univ., Livermore. Lawrence Radiation Lab.); Matlock, David K. (Stanford Univ., Calif. Dept. of Materials Science). 17 Jun 1970. 18p. (CONF-701001–2). Dep. CFSTI.

From 4th International Conference on Plutonium and Other Actinides, Santa Fe, N. Mex.

Linear thermal expansion coefficients of the delta (δ) and epsilon (ϵ) phases and the $\delta \rightarrow \epsilon$ transition contraction were obtained by dilatometry for Pu and a series of Pu–Ga, Pu–Al, and Pu–Ce alloys. The expansion coefficients of the δ phase ($\bar{\alpha}_\delta$) were plotted as a function of solute content and electron/atom concentration (e/a). The results are consistent with an electronic model that allows interband transitions to occur between the 5f band and the conduction band(s) during changes in both solute concentration and temperature. The expansion behavior of the ϵ phase ($\bar{\alpha}_\epsilon$) for the different compositions was observed to be typical of many metals. The $\delta \rightarrow \epsilon$ contraction generally decreased with an increase in solute concentration. This was attributed to the relative extent to which the behavior of the δ and ϵ phases departed from that expected for a normal metal. The correlations obtained for the Pu–Ga and Pu–Al series were similar in the three regions (δ,$\delta \rightarrow \epsilon$, and ϵ), but some variations from these results were obtained in the Pu–Ce series. Such differences are considered to be due to the effect of additional electronic interactions resulting from electronic transfer between Pu and Ce atoms. The similarity in behavior between data obtained from the Pu–Ga and the Pu–Al series is attributed in part to the similar valence behavior of the Ga and Al atoms. (auth)

42100 (UCRL–72547) EFFECT OF HOT WORKING ON ROOM-TEMPERATURE STRENGTH AND DUCTILITY OF A PLUTONIUM–1 WT. PERCENT GALLIUM DELTA-STABILIZED ALLOY. Wheeler, A. D.; Thayer, W. L.; Robbins, J. L. (California Univ., Livermore. Lawrence Radiation Lab.). 19 Jun 1970. 18p. (CONF-701001–18). Dep. CFSTI.

From 4th International Conference on Plutonium and Other Actinides, Santa Fe, N. Mex.

High-purity Pu-1 wt% Ga specimens (annealed for 24 hours at 460°C were hot-worked to a torsional strain of 63 (at a torsional strain rate of 0.04 sec^{-1}) at temperatures of 300, 400, and 500°C and quenched to room temperature within 20 seconds. The effects of this hot working were evaluated by measuring the room-temperature strength and ductility of the quenched specimens by torsion, tension, and compression testing; all three methods showed excellent agreement. Hot working at 300°C appreciably increased the room-temperature yield and ultimate strength without loss of ductility. Hot working at 400 and 500°C significantly increased room-temperature ductility with some concurrent increase in strength. The high capacity for deformation during hot working is associated with a dynamic restoration process which results in a very fine-grained equiaxed room-temperature structure. The mechanism of this restoration process is believed to be concomitant recrystallization. The final grain size increased with increasing hot-working temperature. This grain size increase is due to the fact that grain size is a function of the steady state hot-working stress, and increases with decreasing stress. The effect of grain size on room-temperature yield strength can be described by the Hall–Petch relation. (auth)

42101 (WAPD-Trans–133) INVESTIGATIONS IN THE NIOBIUM–NITROGEN SYSTEM. II. PRECIPITATION PROCESSES IN NIOBIUM–NITROGEN SOLID SOLUTIONS. Gebhardt, E.; Duerrschnabel, W.; Hoerz, G. Translated for Bettis Atomic Power Lab., Pittsburgh, Pa., from J. Nucl. Mater.; 18: 134-48(1966). 26p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 13303.

42102 (WAPD-Trans–134) INVESTIGATIONS IN THE NIOBIUM–NITROGEN SYSTEM. PART III. DEGASSING KINETICS OF NIOBIUM–NITROGEN SOLID SOLUTIONS IN A HIGH VACUUM. Gebhardt, E.; Duerrschnabel, W.; Hoerz, G. Translated for Bettis Atomic Power Lab., Pittsburgh, Pa., from J. Nucl. Mater.; 18: 149-60(1966). 22p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 13202.

42103 STUDIES ON ELECTRODEPOSITED ALLOYS. PART 11. HARDNESS AND ABRASION RESISTANCE OF CHROMIUM–MOLYBDENUM ALLOY ELECTRODEPOSITS. Aotani, Kaoru (Japan Engineering Developments Co. Ltd., Tokyo); Nishimoto, Kazuo. Kinzoku Hyomen Gijutsu; 21: 356–62(Jul 1970). (In Japanese).

Chromium–molybdenum alloy electrodeposits were obtained from the Sargent's chromium plating bath, to which molybdenum salt had been added, under the similar plating conditions to those of the Sargent bath with no addition of the salt. Chromium–molybdenum alloy deposits (containing more than 3% of molybdenum) of about 50μ in thickness gave hardness of Hv 1,000 ~ 1,300, which was higher than that of the conventional hard chromium plating, and their abrasion resistance was also higher than that of the latter. The relation between the molybdenum content of these deposits and the hardness or the amount of abrasion could be expressed by the following equations, respectively. Hardness (Hv) = 95.8x + 715 and amount of abrasion (mg) = −3.8x + 33.3, where x = molybdenum content of the deposits (%). The hardness increased about 100 Hv and the amount of abrasion decreased about 4 mg with the increase in 1% of molybdenum content in the deposits. (auth)

42104 PROPERTIES OF OXIDATION-RESISTING TUNGSTEN SINTERED COMPACT. PART 2. Ito, Hiroshi; Fukunaga, Hiroki (Nippon Tungsten Co. Ltd., Fukuoka). Funtai Oyobi Funmatsuyakin; 17: No. 1, 13–18(Jun 1970). (In Japanese).

Tungsten-chromium sintered compacts were hot-pressed at 1450°C for 30 min in graphite molds. Mechanical properties and high-temperature oxidation resistance of sintered compacts were tested. And also the improvement of oxidation resistance by small additions of Al and Si was tested. It was found that the density of the hot-pressed specimens was more than 95% of the theoretical value; the hardness of the sintered compacts was RHN 56.6 ~ 63.0, higher than the hardness of tungsten; transverse rupture strengths of 30 ~ 40 kg/mm² were obtained; the addition of Cr (>30 wt%) was found to improve the oxidation resistance; and (W–30 Cr)–Si alloy was suitable for tungsten-base high temperature materials. (auth) (Japan)

42105 SUPERHEATING REQUIRED FOR THE BOILING OF ALKALI METALS. Subbotin, V. I.; Sorokin, D. N.; Kudryavtsev, A. P. At. Energ. (USSR); 28: 153-5(1970). (In Russian).

Superheating of sodium in sodium-cooled fast reactors may result in the boiling of the metal in the core; the resulting change of reactivity with time depended on the degree of superheating with respect to the saturation temperature. The value of superheating Δt_H required for boiling was also affected by the temperature distribution and the pressure of the liquid on the solid surface. It was reduced if ultrasonic vibrations were applied to the liquid metal. The analysis indicated that it is impossible to determine beforehand the value of Δt_H for every specific condition; therefore, the highest value of the possible superheating of the heat exchanger at or near the saturation temperature must be used for the calculations. When determining operation of the reactor under emergency conditions, it must be assumed that the sodium may be superheated up to about 200°C at saturation pressures of 1 to 2 atm. (TTT)

42106 MICROSTRUCTURE OF IRRADIATED AND TESTED ZIRCALOY-2. Rau, R. C.; Kefgen, R. B. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. J. Nucl. Mater.; 35: 131-3(Apr 1970).

Tube burst tests were performed on fast neutron-irradiated, pressurized Zircaloy-2 cladding under conditions simulating a thermal surge. The results of transmission electron microscopy examinations of these tubes are given and the failure mode is correlated with the irradiation and thermal histories. An unirradiated control tube was also examined. (G.M.C.)

42107 DISTRIBUTION OF HYDROGEN IN ZIRCONIUM ALLOY FUEL CLADDING: THE EFFECTS OF HEAT FLUX. Asher, R. C. (Atomic Energy Research Establishment, Harwell, Eng.); Trowse, F. W. J. Nucl. Mater.; 35: 115-21(Apr 1970).

Simple methods are described for predicting the approximate distribution of hydrogen in zirconium alloy components subjected to a temperature gradient during corroding. When applied to typical fuel cladding operating in a water-cooled nuclear reactor they indicate that precipitation of hydride should be restricted chiefly to the outer layers of the cladding. An out-of-reactor experiment, in which a tubular specimen was subjected to a radial heat flux of 24.6 W/cm² during corroding, gave a hydride distribution qualitatively and quantitatively in agreement with the predictions. (auth)

42108 INFLUENCE OF ALUMINUM ON THE STABILITY OF QUENCHED β–Zr–Mo. Delvecchio, G. A.; Northwood, D. O.; Rezek, J. (Univ. of Windsor, Ont.). J. Nucl. Mater.; 35: 67-72 (Apr 1970).

A study was made of the effect of deformation on the crystallography of alloys having compositions Zr/3 wt % Mo and Zr/3 wt % Mo/1 wt % Al which were quenched from the high temperature β phase region. The Zr/3 wt % Mo/1 wt % Al alloy was found, after quenching, to consist entirely of the metastable β phase but the Zr/3 wt % Mo alloy was found to contain some ω phase. With the addition of 1 wt % Al to the Zr/3 wt % Mo alloy, the stability of the metastable β phase was reduced and upon rolling, a strain induced transformation to an α' martensitic phase was produced. The martensitic habit plane was found to be close to $(111)_\beta$. Electron diffraction studies of thin foils of this material showed that the orientation relationship between the α' phase and β phase is $(\bar{1}11)_\beta \| (11\bar{2}0)_{\alpha'}$. A parallel is drawn between these results and similar results obtained with titanium alloys. (auth)

42109 MEASUREMENT OF THE EQUILIBRIUM OXYGEN, CARBON, AND URANIUM ACTIVITIES ASSOCIATED WITH THE URANIUM OXYCARBIDE PHASE. Steele, B. C. H.; Javed, N. A.; Alcock, C. B. (Imperial Coll. of Science and Tech., London). J. Nucl. Mater.; 35: 1-13(Apr 1970).

The composition of uranium oxycarbide in equilibrium with pure liquid uranium and appropriate oxygen partial pressures ($10^{-25} > p_{O_2}$ [atm] $> 10^{-35}$) was determined by chemical and x-ray analyses for the temperatures 1473, 1573, and 1648°K. The oxygen partial pressures were established using an isopiestic technique in conjunction with the calcium–calcium oxide equilibria. A similar investigation along the oxycarbide-uranium dioxide phase boundary involved isothermal equilibration with uranium-gold alloys to establish the relevant uranium activities and oxygen partial pressures. The experimental values were analysed by treating the uranium oxycarbide phase as a pseudo-binary solid solution of UO–UC, and it was concluded that a simple regular solution model adequately described the data. Calculations based on this model provided information about the free energy of formation of UO ($\Delta G^\circ = -121\,200 + 22.46\,T$ kcal/mole), and about the carbon monoxide pressures associated with various oxycarbide compositions. Where it was possible to check the calculated values they were in good agreement with measured data. (auth)

42110 ELECTRONIC STRUCTURE OF LIQUID TRANSITION AND RARE-EARTH METALS. Busch, G.; Guentherodt, H.-J.; Kuenzi, H. U.; Meier, H. A.; Schlapbach, L. (Laboratorium fuer Festkoerperphysik, Zurich). Mater. Res. Bull.: 5: 567-76(Aug 1970).

Results of measurements of the Hall coefficient, the electric resistivity and the magnetic susceptibility of liquid transition and rare-earth metals, and of their liquid alloys with metals are reported. The results show filling-up of the unfilled d-bands of liquid Fe, Co, and Ni on alloying, positive Hall coefficients of the liquid rare-earth metals, and a change of sign of these Hall coefficients on alloying. (auth)

42111 ADSORPTION OF INERT GASES ON TUNGSTEN: MEASUREMENTS ON SINGLE CRYSTAL PLANES. Engel, T.; Gomer, R. (Univ. of Chicago). J. Chem. Phys.: 52: 5572-80(1 Jun 1970).

The adsorption of Ar, Kr, and Xe on the (110), (120), (100), (211), and (111) planes of a tungsten field emitter was studied under conditions of immobile adsorption and also under conditions of surface equilibrium. The relative dipole moments and heats of binding could be determined, and it was found that both these quantities were largest on the (110) plane. A discussion in terms of charge transfer bonding is presented to rationalize these results. It was found that chemisorption of oxygen prevented the relatively strong first layer adsorption observed on the clean surface, and also the dipole moment associated with it. (auth)

42112 HEAT CONTENT AND HEAT CAPACITY OF A Pu/1 wt % Ga DELTA-STABILIZED ALLOY AT ELEVATED TEMPERATURES. Rose, R. L. (Univ. of California, Livermore); Robbins, J. L.; Massalski, T. B. J. Nucl. Mater.; 36: 99-107(Jul 1970).

The heat content and heat capacity of a nominal-purity Pu/1 wt % Ga δ-stabilized alloy were determined between 0 and 685°C using an ice calorimeter. The experimental curve for enthalpy as a function of temperature exhibited, in the δ region (0 to 510°C), a positive deviation from linearity. Consequently, the calculated specific heat at constant pressure, C_p, increased with increasing temperature from a value of 7.63 cal/g·atom·°C at 0°C to a value of 10.36 cal/g·atom·°C at 500°C. Enthalpy as a function of temperature in the narrow ϵ region (584 to 640°C) was linear, yielding a constant specific heat of 8.10 cal/g·atom·°C; this value was comparable to the specific heat of unalloyed plutonium in the ϵ phase. It is felt that the relatively high heat capacities of both the δ and ϵ phases are a result of a high electronic specific heat contribution. The decrease in going from the δ to the ϵ phase may be a result of a negative anharmonic contribution for the ϵ phase. The increase with temperature within the δ field may be due to a steep density-of-states curve and enhanced interband transitions. (auth)

42113 DIFFUSION OF CARBON IN STAINLESS STEELS. Agarwala, R. P.; Naik, M. C.; Anand, M. S.; Paul, A. R. (Bhabha Atomic Research Centre, Bombay). J. Nucl. Mater.; 36: 41-7(Jul 1970).

Using residual activity technique, diffusion of carbon-14 in 304, 347, and 316 steels was studied in the temperature range of 450 to 1200°C. The temperature dependence of diffusivity could be expressed as $D_{C/304\ s.\ steel} = 6.18 \exp(-44{,}610/RT)$; $D_{C/347\ s.\ steel} = 0.35 \exp(-40{,}140/RT)$; and $D_{C/316\ s.\ steel} = 0.19 \exp(-37{,}400/RT)$. The activation energy for the diffusion of carbon in steels was explained on the basis of alloying effect of the constituents in steels. Furthermore, thermodynamic calculations for the free energy of formation of various carbides were carried out to predict the carbon pick up by stainless steels as $Cr_{23}C_6$ from uranium carbide in a uranium carbide–stainless steels system. In order to study the segregation of carbon along the grain boundaries of stainless steels, in the present investigation autoradiographic technique was employed. The results indicate that the segregation of carbon is due to the preferential precipitation of $Cr_{23}C_6$ along the grain boundaries of stainless steels. (auth)

42114 DEFORMATION OF MAGNESIUM AND ITS ALLOYS ON OXIDATION. Antill, J. E.; Bennett, M.J.; Chaffey, G. H.; Peakall, K. A.; Warburton, J. B. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 36: 1-19 (Jul 1970).

Experiments were carried out on the mechanisms by which magnesium alloys were deformed by oxidation at 500°C in carbon dioxide-based environments. The composition of the gas and heterogeneous gas reactions were important factors. Slight deformation combined with some enhanced oxidation occurred with water vapor present, these effects being greatly enhanced by the additional presence of hydrocarbons in the gas and by carbon deposits on the specimens. Carbon dioxide appeared to act in the main as an inert carrier. The deformation was derived from a compressive stress within the oxide scale which grew by the transport of both magnesium and oxygen through it by, it is believed, gaseous or surface diffusion through cracks or open pores. The formation of magnesia and/or hydrogen bubbles within the scale was postulated to explain the generation of the compressive stress. In agreement with basic considerations, contamination of the solid corrosion products with sodium and roughening the metal surface reduced deformation for at least short term exposures to gas containing hydrocarbons. (auth)

42115 UTILIZATION OF THE ION ANALYSER FOR THE STUDY OF OXYGEN DIFFUSION IN SOLIDS AND ITS APPLICATION TO ZIRCONIUM. Quataert, D.; Coen-Porisini, F. (CCR EURATOM, Ispra, Italy). J. Nucl. Mater.; 36: 20-8(Jul 1970).

The feasibility of the study of oxygen diffusion in metals by the method of ion-analysis was demonstrated in the case of oxygen diffusion in zirconium. Zirconium samples were oxidized in the 550 to 850°C temperature range, in an atmosphere of pure oxygen, at a pressure of 10^{-3} torr. In the CAMECA ion analyzer, the oxygen penetration curve was determined measuring the total secondary O^--ion current as a function of penetration of the primary ion attack. The diffusion coefficients determined as above are in good agreement with literature values. The activation energy showed a distinct decrease in the low temperature region (550 to 650°C). In local ion analysis a homogeneous oxygen penetration was found and no grain boundary diffusion could be detected. (auth)

42116 TIN SELF-DIFFUSION IN INDIUM–TIN EUTECTIC MELT IN THE PRE-FREEZING RANGE. Petrescu, Maria (Polytechnic Inst., Bucharest). Rev. Roum. Sci. Tech., Ser. Met.; 14: No. 1, 17-37(1969).

The self-diffusion of tin in the liquid In-Sn eutectic alloy, prepared from zone-refined metals, was studied from the freezing point up to a superheating of the melt of 120°. The determinations were made through the capillary-reservoir method in a non-batch diffusion apparatus. Numerical tables of the integrated equation of Fick's second law were used to calculate the diffusion coefficients. The following temperature dependence for tin self-diffusion coefficient was derived from the experimental data: $D = 21.8 \times 10^{-5} \exp(-2{,}184/RT)$ cm²/sec. The experimental data are discussed in terms of the different theoretical models for liquid diffusion mechanism. The implications of the diffusive transport in liquid state in the eutectic crystallization process are discussed. (auth)

42117 DIAPHRAGM CELL MEASUREMENT OF LIQUID Cd–In DIFFUSION COEFFICIENTS AT 300°. Kaiser, R. H.; Shuck, F. O. (Ames Lab., Iowa). Met. Trans.; 1: 2336-7 (Aug 1970).

Measurements of the composition dependence of liquid metal diffusion coefficients led to the development of a modified diaphragm cell. As a test of this type of cell, a series of measurements of diffusion coefficient as a function of composition for the Cd–In system at 300°C were undertaken. The use of the diaphragm cell for liquid metal diffusion measurements at high temperatures was complicated by the necessary manipulations of the cell and the difficulty of finding suitable construction materials. (G.M.C.)

42118 ACTIVITIES IN LIQUID Fe–V–O AND Fe–B–O ALLOYS. Fruehan, R. J. (Lab. for Fundamental Research, Monroeville, Pa.). Met. Trans.; 1: 2083-8(Aug 1970).

The activities in liquid Fe–V–O and Fe–B–O alloys were determined using the following galvanic cells: $Cr-Cr_2O_3(s) \mid ZrO_2(CaO) \mid Fe-V-O$ (l, saturated with oxide); $Cr-Cr_2O_3(s) \mid ThO_2(Y_2O_3) \mid Fe-V-O$ (l, saturated with oxide); and $Cr-Cr_2O_3(s) \mid ZrO_2(CaO) \mid Fe-B-O$ (l, B_2O_3 saturated with Al_2O_3). The solubility of oxygen in Fe–V alloys at 1600°C decreased with increasing vanadium content to a minimum of about 180 ppM at 3 wt % V, and then increased to over 4000 ppM at 36.3 wt % V. Vanadium was found to decrease the activity coefficient of oxygen and the value of the interaction coefficient $e_0^{(V)}$ at infinite dilution of vanadium was −0.14. The activity of vanadium was calculated from the measured electromotive force, and $\log \gamma_V$ was found to be represented well by the quadratic formalism for $N_V < 0.4$: $\log \gamma_V = -0.70\, N_{Fe}^2 - 0.30$. At 1550°C boron decreased the solubility of oxygen down to about 80 ppM at 0.67 wt % B in Fe–B melts in equilibrium with B_2O_3 saturated with Al_2O_3 ($N_{Al_2O_3} = 0.087$). The boron deoxidation product, $K' = (\text{wt \% B})^2(\text{wt \% O})^3$ at infinite dilution of boron was 4.4×10^{-9} and 1.5×10^{-8} at 1550 and 1600°C, respectively. Boron decreased the activity coefficient of oxygen in liquid iron, and the value of the interaction coefficient $e_0^{(B)}$ was −2.6 at infinite dilution of boron. The activity coefficient of boron at infinite dilution (γ_B^0) was 0.083 at 1550°C relative to solid boron. (auth)

42119 SURFACE TENSION OF Fe–Y AND Fe–C–Y ALLOYS AT 1550°C. Mrdjenovich, R. (Ford Motor Co., Dearborn, Mich.); Kaufman, S. M.; Whalen, T. J.; Corey, C. L. Met. Trans.; 1: 2175-8(Aug 1970).

The surface tensions of liquid Fe–Y and Fe–C–Y alloys containing 0 to 2 wt % C and up to 0.8 wt % Y were measured at 1550°C with a sessile drop technique. Yttrium was found to be surface active in both Fe–Y and Fe–C–Y alloys in the composition ranges studied. The addition of carbon reduced the surface tension of Fe–Y alloys. (auth)

42120 DYNAMIC STRAIN AGING AND DUCTILITY MINIMA IN ZIRCONIUM. Ramachandran, V.; Reed-Hill, R. E. (Univ. of Florida, Gainesville). Contract AT(40-1)-3262. Met. Trans.; 1: 2105-9(Aug 1970).

Tensile tests using coarse grained zirconium specimens were conducted at two strain rates, differing by 3 orders of magnitude, between 77 and 1032°K. At each strain rate, peaks were observed when the flow stress was plotted against the temperature. The temperature corresponding to a given peak was observed to rise with increasing strain rate. A pronounced minimum in the strain rate sensitivity of zirconium near 675°K can be explained in terms of the strain rate dependence of these peaks. At each strain rate, the zirconium tensile specimens also showed a minimum elongation at the hardening peak temperature. Since the reduction in area did not pass through a corresponding minimum, the elongation minima do not reflect a true ductility loss. What actually takes place is an increased tendency to neck at the hardening peak temperature. This tendency to promote a neck can be rationalized in terms of variations in the strain rate sensitivity caused by dynamic strain aging. (auth)

42121 TUNGSTEN NEWS, SEPTEMBER 1970. Tungsten News; 1-20(Sep 1970).

The preparation, properties, and uses of tungsten and tungsten-base alloys are reviewed. Applications of tungsten carbide in the machine tool industry are summarized. The use of tungsten as an alloying element is discussed. The recovery and processing of tungsten is briefly described. The preparation and use of tungsten compounds, other than carbides, are discussed. (336 references) (R.C.K.)

42122 ANALYTICAL APPROACH TO THE SHOCK COMPRESSIBILITY OF 18 CUBIC-LATTICE METALS. Huang, Y. K. (Watervliet Arsenal, N. Y.). J. Chem. Phys.; 53: 571-5(15 Jul 1970).

An average value of 11/6 is taken to represent the Grüncisen constant of these eighteen metals: Li, Na, K, Rb, Cs, Fe, Mo, Ta, W, Al, Co, Ni, Cu, Pd, Ag, Pt, Au, and Pb. An analytical model is formulated for the interpretation of shock-wave behavior of these metals. The model is shown to be as heuristic as the classical model of gas dynamics, and the adiabatic indices and compression ratios of both models at shock infinity may now be arranged as orderly spectra ($\frac{1}{3}$, $\frac{1}{2}$, $\frac{1}{5}$, $\frac{1}{7}$) and (4, 5, 6, 7), respectively. The investigation seeks to emphasize the interrelation between shock and isentropic compressibilities, and it also provides favorable evidence for the use of Slater formula to evaluate γ at high pressure. (auth)

42123 SOLID SOLUTION STRENGTHENING IN Nb–Ta AND Nb–Mo ALLOY SINGLE CRYSTALS. Peters, B. C.; Hendrickson, A. A. (Michigan Tech. Univ., Houghton). Met. Trans.; 1: 2271-80(Aug 1970).

The strength of Nb, Nb–Ta, and Nb–Mo alloys was investigated in tension and compression as a function of composition, temperature, and strain rate. The room-temperature properties showed molybdenum to have a significant effect on the strength of niobium while the effects of tantalum were nearly zero. The room-temperature strength was shown to be well correlated with the atomic misfit parameter. Analysis of the low-temperature behavior of Nb–Ta alloys indicated that they behaved similarly to the pure metal while Nb–Mo alloys showed a marked deviation from this

behavior. The strengthening phenomenon occurring in the Nb–Mo alloys at low temperature is interpreted as being an impurity interaction. A transition between the mechanism operating in the pure metal and the impurity interaction occurs at low solute contents. (auth)

42124 PARTITION COEFFICIENT OF MOLYBDENUM IN THE Fe–Mo–Si–O SYSTEM. Thorne, J. K. (Univ. of Michigan, Ann Arbor); Dahl, J. M.; Van Vlack, L. H. Met. Trans.; 1: 2125–32(Aug 1970).

An experimental determination of the partition coefficient of molybdenum, defined as the wt % Mo in the slag divided by that in the liquid metal phase, in the Fe–Mo–Si–O system is reported. The experiments were performed in the temperature range from 1600 to 1800°C, and the system was studied at molybdenum or silica saturation by equilibrating Fe–Mo–Si–O charges in molybdenum or silica crucibles. Data are presented for the Fe–Mo binary liquidus line in the temperature range of this study and on the 1600°C isothermal section in the Fe–Mo–O system, as well as the molybdenum partition coefficients. An ideal solution model is presented that describes the equilibrium relationship between iron and molybdenum in the slag and metal phases in terms of the reaction: $2(FeO) + Mo \rightleftharpoons 2Fe + (MoO_2)$. Two general conclusions can be drawn from this investigation: the partition coefficient of molybdenum between molybdenum-saturated liquid slag and liquid metal in the Fe–Mo–Si–O system is highly dependent on the silica content of the slag phase, ranging from 0.34 at 0% silica and 1600°C, to less than 0.01 at silica saturation; and within the temperature range studied, the molybdenum partition coefficient increases with increasing temperature, but the rate of increase decreases with increasing silica content in the slag. (auth)

42125 DIFFUSIVITY OF TRITIUM IN 304 STAINLESS STEEL IN THE TEMPERATURE RANGE 100° TO 300°C. Chaney, Kenneth F. (Monsanto Research Corp., Miamisburg, Ohio); Powell, Gordon W. Met. Trans.; 1: 2356–7(Aug 1970).

The diffusivity of tritium in Type 304 stainless steel was measured at 100 to 300°C. (G.M.C.)

42126 STRESS RELAXATION, INTERNAL STRESS, AND WORK HARDENING IN SOME Bcc METALS AND ALLOYS. Gupta, I.; Li, J. C. M. (Columbia Univ., New York). Met. Trans.; 1: 2323–30(Aug 1970).

The stress-time relation during stress relaxation is interpreted in terms of a power relation between dislocation velocity and the effective stress. Such interpretation gives not only the velocity-stress exponent, but also the internal stress in the work-hardened state. The velocity-stress exponents thus obtained agree with those obtained from etch pit dislocation velocity measurements. The variation of internal stress with strain shows that work hardening is largely due to the development of internal stresses. The temperature dependence of flow stress arises from the increase of effective stress with decreasing temperature, consistent with a thermally activated process for dislocation motion. (auth)

42127 SEDIMENTATION IN THE SOLID STATE. Anthony, T. R. (General Electric Research and Development Center, Schenectady, N. Y.). Acta Met.; 18: 877–80(Aug 1970).

Solid indium containing a small amount of radioactive gold was subjected to a centrifugal field approximately 100,000 times the force of gravity. Because of the ultra-fast diffusion characteristics of gold in indium, sedimentation of the gold tracer occurred relatively rapidly and a measurable equilibrium sedimentation gradient was produced. The partial molar volume of gold in indium determined from this sedimentation gradient indicates that gold dissolves interstitially in indium. (auth)

42128 AGING CHARACTERISTICS OF Cu–30 PERCENT Ni–Be–Al ALLOYS. Amano, Yoshitsugu; Miki, Masamichi (Himeji Inst. of Tech, Japan). J. Jap. Inst. Metals; 34: 620–5 (Jun 1970). (In Japanese).

For the purpose of obtaining high-strength copper alloys with high corrosion resistance, the aging characteristics and the spring property of Cu-30% Ni containing 0.47 wt% Be and 0.6 to 3.0 wt % Al were investigated by means of the hardness test, x-ray diffraction, optical and electron microscopy (replica method), and the spring test. These alloys showed a maximum hardness value at 500 to 600°C when aged at 300 to 800°C for 1 hr after water quenching from 1050°C, and maximum value in hardness at 600°C increased with the amount of added aluminum. It is concluded that age hardening occurring by heating at 600°C after water quenching from 1050°C is due to the precipitation of NiBe (β) and Ni_3Al, and that the hardening at an earlier stage of aging is due to the precipitation of non-equilibrium phase (β') but the hardening at later stage is due to the precipitation of Ni_3Al. Moreover, it seems that added aluminum suppresses the grain-boundary reaction developed by the precipitation of NiBe and consequently restrains the over-aging of these alloys. The alloy containing about 2.4% Al showed an excellent spring property having a maximum value of about 125 kg/mm² in Kb, when it was cold rolled by 50% after water quenched from 1050°C and aged at 400% to 500°C for 1 hr. (auth)

42129 EFFECT OF Fe AND Si ON AGE HARDENING PROPERTIES OF SUPERSATURATED SOLID SOLUTIONS OF Al–Zr ALLOY BY RAPID SOLIDIFICATION. Ohashi, Teruo; Ichikawa, Riei (Nagoya Inst. of Tech, Japan). J. Jap. Inst. Metals; 34: 604–10(Jun 1970). (In Japanese).

It has been well known that the supersaturated solid solutions of Al–Zr alloys produced by rapid solidification had remarkable age hardening, so the effect of Fe and Si as common impurities in Al on age hardening and mechanical properties of these alloys were investigated by means of microscopic observation, the resistimetric method, and microhardness and tensile tests. The maximum solubility of Zr in solid Al was extended by rapid solidification to about 1 to 1.2 wt % Zr which is equivalent to about four times the equilibrium maximum solubility, and was scarcely affected by a small quantity of Fe and Si. The concentration of Zr which allowed the alloys to harden appreciably during aging could be lowered by the addition of these impurities and subsequently the mechanical properties were improved. It might be shown that the precipitation temperature of Zr from the solid solutions was lowered about 300°C to 250°C, especially by the addition of Si and the precipitation rate of Zr was accelerated by a small quantity of these impurities to promote the age hardening of the alloys. (auth)

42130 COMPATIBILITY OF TANTALUM WITH URANIUM MONOCARBIDE AT HIGH TEMPERATURES. Nomura, Sueo; Muraoka, Susumu; Itami, Hiroharu (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo); 7: 380–1(Jul 1970).

The chemical diffusivity of UC in Ta was studied by layer growth method over the temperature range from 1,200 to 2,000°C. The reaction between UC and Ta was considered to proceed mostly by penetration of U and C into Ta. The thickness of the reaction zone broadens directly as the square root of elapsed time. While it is generally accepted that a light element such as C diffuses into refractory metals much faster than a heavy element, it is to be noted that the U rich brown layer is found between the Ta metal and the TaC layers. (D.H.M.)

Structure and Phase Studies

Refer also to abstract 42296.

42131 (CALT–822–9) SUPERCONDUCTING TRANSITION TEMPERATURES AND LATTICE PARAMETERS OF SIMPLE-CUBIC METASTABLE Te–Au SOLID SOLUTIONS CONTAINING Fe AND Mn. Newkirk, L. R.; Tsuei, C. C. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Aug 1970. Contract AT(04-3)-822. 25p. Dep. CFSTI.

The effects of Fe and Mn impurity atoms on the lattice parameter and on the superconducting transition temperature in Te–Au alloys were investigated. It appears that an anomaly in lattice parameters in these alloys is due to the effect of conduction electrons and is not influenced by the existence of the Te_2Au compound in equilibrium alloys. This conclusion demonstrates that a lattice parameter anomaly of the type occurring in many hexagonal alloys can also occur in cubic systems. In addition it seems that this effect depends only on the concentration of conduction electrons and not on alloy composition. Considering the independent evidence showing that the Fermi surface contacts a Brillouin-zone boundary where the lattice parameter anomaly occurs, the conclusion that the lattice spacings in a cubic system may be influenced by this contact is clearly suggested. (J.R.D.)

42132 (COO–916–17) STRUCTURE AND PROPERTIES OF SOLID SOLUTIONS. Technical Progress Report, September 1, 1969–June 15, 1970. Hendrickson, A. A.; Chen, C. C. (Michigan Technological Univ., Houghton. Dept. of Metallurgical Engineering). 26 Jun 1970. Contract AT(11-1)-916. 8p. Dep. CFSTI.

The causes of solid solution strengthening in close-packed and bcc metals were examined by measurement of crystal flow stress versus temperature, strain rate, and solute content. Crystal flow through dislocation motions was also examined. Data are included on thermally activated glide in Ag–In solid solutions and on strain aging Ag–Zn solutions. (J.R.D.)

42133 (EGG–1183–1476) MEASUREMENTS OF PREFERRED ORIENTATION IN BERYLLIUM FOILS. Technical Report No. L-986. Singman, Leif V. (EG and G, Inc., Las Vegas, Nev.). 1 Apr 1970. 31p. Dep. CFSTI.

The preferred orientation of 15 Be foil specimens was measured using an x-ray diffractometer and NaI counter. Results of counter measurements and film measurements are tabulated for both qualitative and quantitative interpretations. (J.R.D.)

42134 (FEI-164) CONCERNING THE CONNECTION BETWEEN MELTING "VACANCIES" AND SELF-DIFFUSION OF METALS (VARIATIONS ON THE THEME "CONCERNING THE MELTING OF METALS.") Solov'ev, V. A.; Bocharova, I. E. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1969. 71p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The processes of fusion, variations in physical properties usually associated with the formation and displacement of vacancies, and self-diffusion in metals were investigated. The effects which are ascribed to the vacancies, near the melting point are linked with the existence of high-energy atoms. The calculated forces of the activation and variation in the properties associated with these processes agree well with the experimental data. The equations derived for determining the activation energy of self-diffusion in metals agree well with the experimental results. On this basis, the activation energy of self-diffusion for 27 metals for which at the present time, no experimental data are available were predicted. (auth)

42135 (IS-T-362) THERMAL STUDY OF THREE In-Tl ALLOYS IN THE NEIGHBORHOOD OF THE F.C.T.-F.C.C. TRANSITION; HEAT CAPACITIES FROM 5 TO 300°K. Schwartz, Robert Gerald (Ames Lab., Iowa). May 1970. Contract W-7405-eng-82. 75p. Dep. CFSTI.

Thesis.

The heat capacities and thermodynamic functions of three In-Tl alloys, having compositions of 34.6, 28.9 and 18.8-at. % Tl, have been measured from 5 to 300°K. In this temperature range, the 28.9-at. % Tl alloy transformed martensiticly from fct to fcc, while the 34.6-at. % Tl alloy remained fcc and the 18.8-at. % Tl alloy remained fct. The entropy at 298°K was found to be 61.6 ± 1.6 eu, 61.4 ± 2.0 eu, and 61.1 ± 1.6 eu for the three alloys, respectively. The alloy that transformed from fct to fcc exhibited the expected deviations from normal heat-capacity behavior. While no alloy exhibited anomalous behavior below 195°K, above 195°K all alloys exhibited anomalous 5 to 8% rises in heat capacity, occurring over a 25 to 35°K range, depending on the alloy composition. This rise in heat capacity was irreversible in the 28.9 and 34.6-at. % Tl alloys, but reversible in the 18.8-at. % Tl alloy. This behavior was corroborated by the anomalous thermal expansion coefficients of fcc and fct alloys reported by previous investigators. The anomalous behavior of the fct alloy is believed to correlate with the "rubber-like" to plastic mechanical property changes previously observed in fct alloys. No mechanical property data for fcc alloys exist, but because the heat capacity of the fcc alloys is similar to the heat capacity of the fct alloy, it is believed that the "rubber-like" to plastic mechanical property changes should exist in fcc alloys as well. The cause of the "rubber-like" to plastic change is not known. auth)

42136 (UCRL-72225) INVESTIGATION OF THE PLUTONIUM-SILVER SYSTEM. Wood, David H.; Cramer, Eugene M.; Wallace, Peter L. (California Univ., Livermore. Lawrence Radiation Lab.). 19 Jun 1970. 16p. (CONF-701001-19). Dep. CFSTI.

From 4th International Conference on Plutonium and Other Actinides, Santa Fe, N. Mex.

Metallographic, x-ray diffraction, and differential thermal analysis have been used in a limited investigation of the plutonium-silver phase diagram. Two compounds were observed: $PuAg_{3.4}$, which melts congruently at 977°C, and $PuAg_2$, which melts peritectically at 817°C. A region of liquid immiscibility extends from about 2 to 59 at. % silver, at which composition there is a monotectic reaction at 795°C. A eutectic between $PuAg_{3.4}$ and silver was found at 801°C and 90.8 at. % silver. These results are at variance with the literature in several respects. The occurrence of liquid immiscibility is explained in accordance with the thermodynamic reasoning of Hume-Rothery and Anderson (1960). (auth)

42137 (UCRL-72507) DEFORMATION OF CRYSTALS OF ALPHA PLUTONIUM IN COMPRESSION. Liptai, Robert G. (California Univ., Livermore. Lawrence Radiation Lab.); Friddle, Robert J. (Argonne National Lab., Ill.). 11 Jun 1970. 12p. (CONF-701001-3). Dep. CFSTI.

From 4th International Conference on Plutonium and Other Actinides, Santa Fe, N. Mex.

The crystal structure of alpha plutonium was complex and of low symmetry (monoclinic, space group $P2_1/m$). Several slip planes were suggested, namely, (020) and (001). It was reported that slip planes near (11$\bar{4}$), (213), and ($\bar{3}2\bar{3}$) were operative at room temperature in small-grained specimens. In the present study, large crystals of alpha plutonium (to 2 × 2 × 5 mm) were prepared by high-pressure techniques. The results of a study to identify the deformation mechanisms and the stress-strain characteristics of alpha plutonium at room temperature are reported. All tests were compressive. The slip planes were identified by two-surface analysis. Slip was the dominant deformation mechanism; however, some evidence suggested that twinning deformations were present. Results showed that several slip planes were operative, apparently depending on the crystallographic direction of strain. Although most samples revealed only one slip plane, three planes were noted in one compression sample. The following slip planes were identified: ($\bar{1}02$), (112), (111), (10$\bar{1}$), (4$\bar{1}$1), (118), ($\bar{2}13$), ($\bar{3}2\bar{3}$), (4$\bar{1}$5), (100), and (010). Plastic deformation was usually less than 1%; but in one case, deformation was over 13%. Most samples taken to failure exhibited brittle fracture. (auth)

42138 (UCRL-72557) PHASE TRANSFORMATIONS IN THE ACTINIDES. Goldberg, Alfred; Massalski, Tadeusz B. (California Univ., Livermore. Lawrence Radiation Lab.). 29 Jun 1970. 122p. (CONF-701001-5). Dep. CFSTI.

From 4th International Conference on Plutonium and other Actinides, Santa Fe, N. Mex.

Solid-state transformations that occur in metals that belong to the actinide series, in particular, plutonium and uranium, and to a lesser extent thorium, neptunium, and americium, are summarized. In Pu, both the $\beta \rightarrow \alpha$ and $\delta \rightarrow \gamma$ transitions are mainly martensitic during rapid cooling. On slow cooling the latter transition most likely occurs by a d-n-a-g process. The $\delta \rightarrow \alpha$ skip transition probably occurs by a martensitic transformation. The remaining transitions all appear to take place by diffusional processes. The low-temperature $\beta \rightarrow \alpha$ transformation in U is martensitic. On slow cooling, it occurs primarily by d-n-a-g processes. The remaining transitions, $\beta - \alpha$ and $\gamma \rightleftharpoons \beta$, take place by d-n-a-g processes under all conditions. (M.C.G.)

42139 TERNARY NITRIDES OF CALCIUM AND STRONTIUM WITH MOLYBDENUM AND TUNGSTEN. Karam, Ronald; Ward, Roland (Univ. of Connecticut, Storrs). Inorg. Chem.; 9: 1849-52(Aug 1970).

Ternary nitrides of molybdenum and tungsten with the alkaline earth metals calcium and strontium were formed by heating the transition metals with the alkaline earth nitrides in oxygen-free, dry nitrogen at atmospheric pressure. A hexagonal phase (a = 11.40 ± 0.01 Å, c = 7.45 ± 0.01 Å) was assigned the tentative formula Ca_5MoN_5. A cubic phase was obtained in the Sr-Mo-N system at 750° which is isostructural with $Sr_{27}Re_5N_{28}$. Tungsten yields analogous compounds. At higher temperatures, the strontium compounds form other unidentified phases. Ca_5MoN_5 is an insulator with a temperature-independent paramagnetism similar to $Sr_{27}Re_5N_{28}$. $Sr_{27}W_5N_{28}$ and presumably $Sr_{27}Mo_5N_{28}$ are diamagnetic. (auth)

42140 CRYSTAL STRUCTURE OF $Yb_{11}Sb_{10}$. Clark, H. L.; Simpson, H. D.; Steinfink, H. (Univ. of Texas, Austin). Inorg. Chem.; 9: 1962-4(Aug 1970).

Atomic parameters and observed and calculated structural factors for $yb_{11}Sb_{10}$ are tabulated. Interatomic distances in $Yb_{11}Sb_{10}$ are also included. (J.G.B.)

42141 EFFECT OF OXYGEN ON THE EQUILIBRIUM $\beta/\alpha + \beta$ TRANSFORMATION TEMPERATURE OF ZIRCONIUM-NIOBIUM ALLOYS. Hunt, C. E. L.; Niessen, P. (Univ. of Waterloo, Ont.). J. Nucl. Mater.; 35: 134-6 (Apr 1970).

The $\beta/\alpha + \beta$ phase transformation temperatures for a series of zirconium alloys containing up to 5 wt % niobium and 5300 ppM oxygen were determined. (G.M.C.)

42142 ANNEALING TEXTURES IN ZIRCALOY TUBING. Tenckhoff, E.; Rittenhouse, P. L. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater.; 35: 14-23(Apr 1970).

The annealing textures in Zircaloy tubing were more complex than those reported for rolled and annealed zirconium or titanium sheet. Different features of annealing textures could develop, depending on whether the tubing was hot extruded, rocked, or drawn and on the relative reductions in wall thickness and diameter before annealing. The differences were the result of variation in deformation temperature, degree in deformation, and deformation method. Furthermore, the development of annealing textures was influenced by the effects of alloying additions and impurities. (auth)

42143 EXAMINATION OF α/γ TRANSFORMATION IN VERY PURE BINARY ALLOYS OF IRON WITH MOLYBDENUM, VANADIUM, TUNGSTEN, NIOBIUM, TANTALUM, ZIRCONIUM, AND COBALT. Fischer, Wilhelm Anton; Lorenz, Klaus; Fabritius, Heinz; Schlegel, Dieter (Thyssen Roehrenwerke AG, Duesseldorf. Max-Planck-Institut fuer Eisenforschung, Duesseldorf). Arch. Eisenhuettenw.; 41: 489-98(May 1970). (In German).

Susceptibility measurements on binary alloys rich in iron at temperatures of up to 1400°C were made. The boundaries of the

two-phase field in the systems iron–molybdenum, iron–vanadium, iron–tungsten, iron–niobium, iron–tantalum, iron–zirconium and iron–cobalt were determined. The range of existence of the ϵ-phase in the systems iron–niobium, iron–tantalum and iron–zirconium were determined. Thermodynamic data from the phase boundaries were determined and their allocation to the atomic number of the alloying elements in the periodic table made. Comparison of the results of examination with data taken from the literature is presented. (auth)

42144 TEXTURE PRODUCED IN COLD-ROLLED AND RECRYSTALLIZED ZIRCALOY-2, AND Zr–2.5 WT PERCENT Nb ALLOYS. Reid, I. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. Met. Quart.; 9: 345-52(Jan-Mar 1970).

Cold rolling Zircaloy-2 develops a texture with the {0001} plane of the grains oriented parallel to the rolling plane and the [10$\bar{1}$0] direction parallel to the rolling direction. In cold-rolled Zr–2.5 wt % Nb the grains are tilted towards the transverse direction so that the {10$\bar{1}$4} plane is parallel to the rolling plane and the [2$\bar{1}$3$\bar{2}$] direction parallel to the rolling direction. Beta annealing of Zircaloy-2 and Zr–2.5 wt % Nb results in a rotation about the hexagonal axis along with a reorientation so that some grains have their [0001] direction close to the rolling direction. Alpha annealing of Zircaloy-2 results only in the rotation of the grains about their hexagonal axis. Although fiber texture banding in α-annealed heavily cold worked zirconium has been reported, it was not observed in Zircaloy-2 after reducing 95% or after α-annealing. (auth) (Canada)

42145 EXPERIMENTAL WORK ON THE NIOBIUM–TIN CONSTITUTION DIAGRAM AND RELATED STUDIES. Charlesworth, J. P.; Macphail, I.; Madsen, P. E. (Atomic Energy Research Establishment, Harwell, Eng.). J. Mater. Sci.; 580-603(Jul 1970).

Three intermetallic phases Nb_3Sn, Nb_6Sn_5, and $NbSn_2$ are formed in the niobium-tin system. Nb_6Sn_5 and $NbSn_2$ appeared to be stoichiometric with narrow homogeneity range, but Nb_3Sn could exist over a wide composition range from about 73 to 83 at. % niobium although the niobium-rich compositions were not formed on annealing below 1400°C. Nb_6Sn_5 and $NbSn_2$ formed peritectically at 930 and 845°C respectively. The three phases appeared to be stable to low temperatures, but Nb_3Sn and Nb_6Sn_5 were slow to form below about 800°C. The solubility of niobium in liquid tin was small at temperatures below 1000°C and the solid solubility of tin in niobium decreased from about 9 at. % tin at the peritectic temperature of Nb_3Sn to about 1 at. % tin at 1495°C and was negligible below 1000°C. An equilibrium diagram is constructed from the present data and from other published information. (auth) (UK)

42146 DECOMPOSITION OF THE METASTABLE BETA PHASE IN THE ALL-BETA ALLOY Ti–13V–11Cr–3Al. Narayanan, G. Hari; Archbold, T. F. (Univ. of Washington, Seattle). Met. Trans.; 1: 2281-90(Aug 1970).

The phase transformations which occurred in the all-β titanium alloy Ti-13V-11Cr-2Al at temperatures below ~500°C were studied by transmission electron microscopy, x-ray diffraction, and electrical resistivity techniques. The decomposition of the metastable β phase was found to proceed through a transition reaction leading to the formation of two bcc phases rather than through the precipitation of the ω phase as was previously reported. An interpretation of the observed decomposition sequence, based on thermodynamic reasoning, is presented. The decomposition characteristics of the Ti–13V–11Cr–3Al alloy were compared with those of a Ti–13V–11Cr alloy to determine the influence of aluminum on the transformation behavior. (auth)

42147 USE OF THE ELECTRON MICROPROBE FOR MEASURING AIR CONTAMINATION IN Ti:6Al-4V. Olsen, R. H. (Boeing Co., Renton, Wash.). Metallography; 3: 183-95(Jun 1970).

Two unique methods were developed to determine the extent of air contamination in Ti–6Al–4V by using the electron microprobe. One method gives a rapid measure of the contamination depth; the second results in a quantitative oxygen profile. The two methods are described in some detail and their demonstration in three heat-treatments is discussed. The results are compared with the more conventional optical metallography and microhardness measurements. (auth)

42148 NATURE OF FRECKLES IN NICKEL BASE SUPERALLOYS. Giamei, A. F.; Kear, B. H. (Pratt and Whitney Aircraft, Middletown, Conn.). Met. Trans.; 1: 2185-92(Aug 1970).

Freckles are chains of equiaxed grains that were previously observed in macroetched ingots of both iron and nickel base alloys formed by the consumable arc process. These defects were observed in nickel base superalloys in both directionally solidified polycrystalline and single crystal ingots. Such ingots exhibited a relatively periodic distribution of vertical freckle trails around their circumference which were particularly suitable for study. This paper investigates the nature of freckles, examines the conditions under which they occur and specifies a set of consistent observations which any successful model for freckling must explain. Visual, chemical, electron probe, metallographic, and x-ray diffraction data are presented which establish the appearance, composition, and orientation differences between freckled and normal regions in single crystals of the nickel base superalloys Udimet 700 and Mar-M200. It is shown that the freckle lines are linear assemblies of small random equiaxed grains which are enriched in all but the inversely segregated solute species. Excessive interdendritic porosity and feeding shrinkage are observed in the vicinity of a freckle line. Some correlations of the tendency toward freckling and the geometric distribution of freckle lines are made with growth rate, thermal gradient, and interface shape. The dependence of freckling tendency on composition is examined in the Ni–Al system. (auth)

42149 AS-QUENCHED FORM OF THE OMEGA PHASE IN Zr–Nb ALLOYS. Dawson, C. W.; Sass, S. L. (Cornell Univ., Ithaca, N. Y.). Met. Trans.; 1: 2225-33(Aug 1970).

The as-quenched ω phase was examined in the Zr–Nb system using high resolution dark field electron microscopy and selected area diffraction. The morphology of the ω phase was shown to be based upon $\langle 111\rangle \| \langle 0001\rangle$ rows of particles 10 to 15 Å in diameter with an interparticle spacing of 15 to 25 Å. The row morphology was in agreement with previous observations on a Zr–Ti alloy. In the Zr-8 wt % Nb alloy, clusters made up of many rows were observed and, as the solute content increased up to 15 wt % Nb, the clusters became smaller and the length of the individual rows decreased. Sharp ω reflections and {111} planes of intensity in reciprocal space were observed in the 8 wt % Nb alloy. As the niobium content increased, the ω reflections broadened and became more diffuse, while the thickness of the {111} planes of intensity increased. It was suggested that the sharp ω reflections resulted from scattering by the clusters while the {111} planes of intensity result from scattering by isolated rows of particles. Comparison of the ω morphology with the diffraction effects showed good agreement with these suggestions. In alloys with 15 wt % and higher Nb content, the 0001 and 0002 broadened ω reflections were observed to be displaced toward each other along a $\langle 111\rangle \| \langle 0001\rangle$ direction away from the positions corresponding to the ideal hexagonal structure of the ω phase. It was suggested that these displacements are related to the mechanism of the transformation, which is thought to involve instability of the bcc structure relative to atomic displacement waves. The electron diffraction patterns were in agreement with predictions concerning this mechanism. (auth)

42150 MOLYBDENUM IN Nb–C ALLOYS. Ostermann, F.; Kibbey, E. E. (Air Force Materials Lab., Wright-Patterson Air Force Base, Ohio). Met. Trans.; 1: 2257-63(Aug 1970).

The effects of molybdenum alloying additions to niobium on the carbide phases and their precipitation behavior were investigated. The experimental alloys included Nb–0.1C, Nb–15Mo–0.1C, and Nb–30Mo–0.1C. After selected heat treatments the microstructural changes were determined by metallography and the carbide phases were extracted and identified by x-ray diffraction and chemical analysis. The results were essentially in agreement with recent phase diagram determinations. Additions of 30 wt % Mo appeared to slightly increase the solubility of carbon in niobium at temperatures around 1650°C. The solubility of molybdenum in Nb_2C was very small. Discontinuous precipitation of β–Nb_2C was found to occur in the Nb–30Mo–0.1C alloy during annealing at 1200°C. The important, overall effect of molybdenum in Nb–C alloys was to decrease the rate of niobium carbide precipitation so that appreciable carbon supersaturation could be achieved even after comparatively slow furnace cooling. (auth)

42151 PHASE RELATIONS AND CRYSTALLOGRAPHIC DATA FOR THE Pr–Zn SYSTEM. Mason, J. T.; Chiotti, P. (Ames Lab., Iowa). Met. Trans.; 1: 2119-23(Aug 1970).

Metallographic, thermal, x-ray, and resistivity data were employed in establishing the phase diagram of the Pr–Zn system. Eight compounds, three eutectics, and a eutectoid were observed. The compounds PrZn, $PrZn_2$, and Pr_7Zn_{17} melted congruently at 882, 898, and 978°C, respectively. The compounds $PrZn_3$, Pr_2Zn_{11}, $PrZn_{11}$, $PrZn_{4.46}$, Pr_3Zn_{22}, and $PrZn_{11}$ underwent peritectic decomposition at 833, 855, 891, 956, and 743°C, respectively. The eutectic temperatures and compositions in wt % Zn were 576°C and 11.9 %, 833°C and 39.0 %, and 830°C and 56.8 %. The eutectoid reaction occurred at 558°C and 5.2 % Zn. The lattice parameters of the compounds in the system were determined using x-ray powder diffraction methods. Single crystal

x-ray techniques were used to show that $PrZn_3$ has the YZn_3 (space group Pnma) type structure. (auth)

42152 STUDY OF THE RECRYSTALLIZATION PROCESSES IN THE Ni_3Al–Ni_3Nb ALLOYS. Arbuzov, M. P.; Chuprina, V. G. (Inst. of Problems in Material Studies, Kiev). Ukr. Fiz. Zh.; 15: 228-30(Feb 1970). (In Russian).

Recrystallization of γ'-phase (solid solution on the base Ni_3Al) was studied in the Ni_3Al–Ni_3Nb alloys by the x-ray powder method. A conventional temperature of recrystallization was determined, i.e., the temperature of annealing deformed powder at which for an hour an undistorted grain grows up to the dimensions 10^{-4} to 10^{-3} cm. It was found that an increase in the Ni_3Nb concentration in alloys caused an increase in the recrystallization temperature for the γ'-phase. It might be due to the fact that niobium decreases the diffusion mobility of atoms in the Ni_3Al alloy. (auth)

42153 STUDIES ON V–Ga INTERMEDIATE PHASES FORMED BY DIFFUSION. Tanaka, Yoshiaki; Tachikawa, Kyoji (National Research Inst. for Metals, Tokyo). J. Jap. Inst. Metals; 34: 597-603(Jun 1970). (In Japanese).

Compositions and structures of V-Ga intermediate phases formed by diffusion at high temperatures were studied using electron probe microanalysis, optical metallography, and x-ray diffraction. Superconducting transition temperatures, T_c, of the intermediate phases were also measured. Five different intermediate phases, V_3Ga, 2V-Ga, V_3Ga_2, VGa, and VGa_2 were formed in the V-Ga diffusion couples. The V_3Ga compound, having the cubic (A-15) structure, was stable below 1300°C and transformed to V-Ga solid solution above 1300°C. The 2 V-Ga phase, which was a V-Ga solid solution, decomposed into V_3Ga and V_3Ga_2 by an eutectoid reaction at 1100°C. The hexagonal V_3Ga_2 compound was stable below 1200°C. The VGa compound was stable between 1050 and 1200°C and decomposed into V_3Ga_2 and VGa_2 at 1050°C. The tetragonal VGa_2 compound was stable below 1050°C. The formation rates of V_3Ga, V_3Ga_2 and VGa_2 showed maxima at 1100, 1000, and 700°C, respectively. The formation rates of V_3Ga_2 and VGa_2 were more than one order of magnitude larger than that of V_3Ga. T_c of V_3Ga formed at 800°C was 14.5°K. T_c decreased as the heat treatment temperature increased. V_3Ga was the only phase in V-Ga system which became superconducting above 4.2°K. (auth)

42154 BETA TO ALPHA PHASE TRANSFORMATION IN ZIRCALOY-4. Holt, R. A. (Chalk River Nuclear Labs., Ont.). J. Nucl. Mater.; 35: 322-34(Jun 1970).

Two different Widmanstätten morphologies were observed in nominally similar Zircaloy-4. This difference in structure was shown to be coincident with a difference in the kinetics of the beta to alpha phase transformation. Discussion of existing equilibrium data, and experimental investigation of the equilibrium transformation showed that this difference in kinetics was a result of a difference in nucleation mechanism rather than a difference in growth mechanism. This was related to the abundance and size of second phase particles, insoluble in the beta phase, which acted as nucleation sites in preference to the beta grain boundaries. Classical nucleation theory is used to explain this preference. There is evidence that some of the particles are NaCl cubic structure with a lattice parameter of 5.25 Å which corresponds to zirconium phosphide (ZrP). It is also suggested that the presence of suitable nucleation sites may depend on the carbon, oxygen and nitrogen, as well as phosphorous contents. (auth)

42155 STUDY OF THE SHEAR TRANSFORMATIONS FROM THE GAMMA-PHASE IN URANIUM–MOLYBDENUM ALLOYS CONTAINING 6.0 TO 12.5 AT. PERCENT MOLYBDENUM. Howlett, B. W. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 35: 278-92(Jun 1970).

A dilatometric investigation was made of the shear transformations from the γ phase of uranium–molybdenum alloys in the composition range 6.0 to 12.5 at. % molybdenum. It was found that there were two shear transformations occurring successively over most of this composition range. The one at the higher temperature was a transformation from the γ_0 to γ_0 phase (a tetragonal variant of the γ phase) with c/a <0.5, while that at the lower temperature was from γ_0^1 with c/a <0.5 to α_b'' (a monoclinic variant of the α-phase of uranium). The enthalpies of these two transformations were also measured as a function of composition and cooling rate. It was found that the enthalpy depended on the magnitude of the martensitic shear which was in turn controlled by the cooling rate because of the effect this had on the degree of order. (auth)

42156 STRESS ORIENTATION OF HYDRIDE IN ZIRCONIUM ALLOYS. Ells, C. E. (Chald River Nuclear Labs., Ont.). J. Nucl. Mater.; 35: 306-15(Jun 1970).

J. C. M. Li's theory of stress orientation of disc shaped precipitates was applied to the problem of stress orientation of hydride in zirconium alloys. It is shown that the stress orientation of the hydride occurs through orientation of the nuclei rather than through preferential growth of stable nuclei, the effect of crystallographic texture is clearly defined, and the experimentally observed dependence on stress is explained. Insufficient experimental data were available to make a quantitative test of the theory for metallurgical conditions in which the hydride was precipitated on both inter- and intra-granular sites in the alloy, but the experimental observations are shown to be consistent throughout. In particular, the susceptibility of quenched and aged Zr/2.5 wt % Nb to stress orientation, compared with the much lower susceptibility of cold worked Zr/2.5 wt % Nb, follows logically from the theory, and the mechanistic basis for the apparent critical stress is demonstrated. (auth)

42157 EFFECT OF ZIRCONIUM CARBIDE ON THE $\beta \rightarrow \alpha$ TRANSFORMATION STRUCTURE IN ZIRCALOY. Oekvist, G.; Kaellstroem, K. (Sandvik Steel Works, Sandviken, Sweden). J. Nucl. Mater.; 35: 316-21(Jun 1970).

In Zircaloy, a brazing operation involving the $\beta \rightarrow \alpha$ transformation could result in either of two metallographic structures. A basketweave structure was associated with a fairly high carbon concentration (100 to 200 wt ppM) whereas a parallel plate structure was characteristic of a low carbon concentration (<50 wt ppM). In the basketweave structure microscopy revealed 5×10^8 cm^{-3} particles of diameter >0.4 μm as nucleation sites for α-phase plates, while no such particles were found in the parallel plate structure. Microprobe analysis revealed carbon in the particles. Scanning electron microscopy showed a complex shape of the particles, indicating retarded spheroidization due to low carbon solubility. Electron diffraction patterns of extraction replicas showed the particles to be fcc with lattice parameter about 4.7 Å. X-ray diffraction of the particles convincingly proved the presence of fcc zirconium carbide with lattice parameter 4.68 Å. The effect of zirconium carbide in causing basketweave structure was confirmed in full scale production of Zircaloy by adding carbon to a melt of low carbon zirconium sponge. (auth)

42158 PHASE DIAGRAMS: MATERIALS SCIENCE AND TECHNOLOGY. VOLUME I. THEORY, PRINCIPLES, AND TECHNIQUES OF PHASE DIAGRAMS. Alper, Allen M. (ed.). Refractory Materials, A Series of Monographs. Volume 6. New York; Academic Press Inc. (1970). 370p. $16.00.

The relations of thermodynamics to phase diagrams are described and methods for interpreting phase diagrams are reviewed. Information is also included on computer calculations of metal phase diagrams, methods of phase equilibria determination, relations of phase diagrams with solidification, use of phase diagrams in high-pressure research, and metastable phase diagrams. (J.R.D.)

Radiation Effects

Refer also to abstracts 42783–42785, 42787, and 43762.

42159 (CEA-N-1382) ENERGY TRANSFERRED TO A ZIRCONIUM LATTICE IRRADIATED BY NEUTRONS. Barre, Bertrand; Devillers, Christian (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Aug 1970. 11p. (In French). Dep. CFSTI (U. S. Sales Only).

The neutron energy spectra greatly influence the creep of Zircaloy under irradiation. The DOMISOL program was used to determine the energy transferred to the lattice by elastic and inelastic collisions, and radiative capture. (auth) (France)

42160 (CEA-R-4033) INTERNAL FRICTION AND MODULUS CHANGES DUE TO THE DEFECTS CREATED IN MAGNESIUM BY NEUTRON IRRADIATION AT LOW TEMPERATURE. Hillairet, Jacques; Trabut, Louis; Le Diouron, Raymond (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jun 1970. 43p. (In French). Dep. CFSTI (U. S. Sales Only).

The defects produced in magnesium by neutron irradiation at 80°K were studied by means of internal friction and dynamic modulus measurements. Both torsional and flexural vibrations were used for this study. The modulus decreases under irradiation; the change amounts to about 7 percent at saturation. This change is discussed in terms of the elastic bulk effect and of the notion of deformability of a point defect. The annealing behavior of the internal friction and modulus is also presented. This information is used to analyze the recovery stages observed in magnesium by other techniques, such as electrical resistivity and stored energy. (auth) (France)

42161 (CONF-700211-3) EMBRITTLING CHARACTERISTICS OF PRESSURE VESSEL STEEL PLATE. Ogura, Nobukazu. Translated from Japan Atomic Energy Society Meeting, Tokyo, February 12-13, 1970. 5p. Dep. CFSTI.

Prevention of embrittling rupture accidents is extremely difficult. This is compounded by recent economic requisites which impose great restrictions on using high-class materials. Investigations on accidents raised many unanswered questions although there are many vessels which were successfully manufactured and are being used safely. What is important, is to minimize the probability of accidents by thoroughly studying actual ruptures or cracking accidents and to put such knowledge to work in detailed points of designs and in all stages of production and processing. (auth)

42162 (COO-1198-735) LOW TEMPERATURE ANNEALING OF ELECTRON IRRADIATED GERMANIUM. Hyatt, William D. (Illinois Univ., Urbana). Jun 1970. Contract AT(11-1)-1198. 91p. Dep. CFSTI.

Thesis.

Antimony doped N-type germanium has been irradiated using 1.1 MeV electrons at 5°K. The defects produced have been studied by measuring the voltage-dependent capacitance of a metal-germanium junction formed at the surface of a germanium sample. These measurements were made at 10°K and directly gave the fixed charge density near the surface of the sample. The production and recovery of defects seen near the surface is the same as seen in bulk experiments. A 0.5 MeV electron beam was used to cause radiation annealing of the defects at 5°K. The fraction recovered during radiation annealing is directly proportional to $\sqrt{t}$. A model based on diffusion-limited recovery theory is used to explain these results. This model is also used to discuss the results of previous experiments. The temperature dependence of the observed recovery at 5°K gave a defect migration energy of 0.0044 ± 0.0008 eV. (auth)

42163 (EURAEC-2139) A NEW DETERMINATION OF THE EMBRITTLEMENT IN STEEL USING SMALL SPECIMENS (≈ 0.2 cc) IN PARTICULAR WITH RESPECT TO IRRADIATION. Progress Report, January 1-December 31, 1969. Koning, C. (Metaalinstituut TNO, Delft (Netherlands)). 5 Feb 1970. Contract 060-64-11-TEEN. 25p. (EUR-4029; M-70-76). Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

Specimens of five different reactor pressure vessel steels for stress wave attenuation (S.A.T.) and tensile tests were irradiated in the BR2-reactor. Two fast neutron doses (>0.1 MeV) were used, viz. ≈2.5×10^{19} and ≈8.3×10^{20} n/cm^{-2} at an irradiation temperature of 285°C, corresponding with a representative service temperature of boiling water reactors. After a cooling time and dismantling from the irradiation capsules, the specimens were tested. Three series of S.A.T.-specimens of the reactor pressure vessel steel type 1.2 MD 07 with dimensions 6 × 6 ϕ mm were investigated in the S.A.T. for the nonirradiated condition and after two fast neutron fluences of 2.8×10^{19} and 8.3×10^{20} n.cm^{-2} at an irradiation temperature of 285°C. The relative energy absorption versus temperature curves at performance of the S.A.T. decrease after irradiation of the specimens at 285°C as was expected. However, the shifts in transition temperature proved negative. A possible explanation for this phenomenon is suggested. (auth)

42164 (ORNL-4580) INVESTIGATION OF FAST NEUTRON RADIATION DAMAGE IN AN AUSTENITIC STAINLESS STEEL. Bloom, Everett E. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 175p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The nature of irradiation damage in Type 304 stainless steel has been deduced from a study of microstructure and density of specimens irradiated by neutrons in the temperature range 370 to 800°C to fluences of 1×10^{18} to 5×10^{22} neutrons/cm^2 (E > 0.1 MeV). Results of the investigations are the basis for the concept that nucleation occurs by the stabilization of void nuclei by the helium produced by (n,α) reactions. At low fluences and thus low helium concentrations, helium collects on dislocations and the first voids appear at these defects. As the helium concentration increases, stable nuclei form in the matrix and give a more uniform void distribution. Helium stabilization of void nuclei gives a void nucleation rate which is initially low, then increases until saturation of the void concentration occurs. The decrease in void growth rate is thought to be due to the buildup of a shell around the void within which the vacancy diffusivity is lower than in the homogeneous alloy. (J.R.D.)

42165 (RN-S-365) REVIEW OF HIGH-TEMPERATURE RADIATION EMBRITTLEMENT OF ENGINEERING ALLOYS. Studt, P.; Dixon, C. E.; Baciarelli, R. (Aerojet-General Corp., Sacramento, Calif.). Feb 1967. Contract SNP-1. 150p. Dep. CFSTI.

The known characteristics and the theoretical studies of high-temperature radiation embrittlement are reviewed. This embrittlement is attributed primarily to the presence of helium, which results from the thermal-neutron $^{10}B(n,\alpha)^7Li$ reaction; however, many details of the embrittlement mechanism are not understood. A compilation of mechanical-property radiation test data is presented for several high-temperature alloys. (auth)

42166 ACTIVATION TREATMENT STUDY OF Cu-Be ALLOY AND ITS SECONDARY ELECTRON EMISSION CHARACTERISTICS. Fujii, Yasuo; Kanematsu, Futoshi (Osaka City Univ.). Shitsuryo Bunseki; 18: 994-1003(Jun 1970). (In Japanese).

Activation treatment of commercially available Cu-Be (2%) alloy was investigated. The characteristics of secondary electron emission and the decay of δ due to the electron bombardment were measured for the samples treated at various condition. The δ_{max} values of these treated samples mainly distribute mostly between 4 and 6, and the yield of almost all these treated samples decreased to about 80% of their values. The best result was obtained under the heat treatment at 800°C for 15 minutes keeping at the oxygen pressure $P_0 = 6 \times 10^{-3}$ torr and then for subsequent 10 minutes in high vacuum. Although the δ_{max} values for these samples are a little low, between 4 and 5, no decay of the yield was observed after 15 hours' electron bombardment at 400 eV. The electron diffraction study showed that the surface products for the most of these samples are only BeO. (auth)

42167 RADIATION STRENGTHENING OF CERTAIN Ni-Fe-Cr ALLOYS. Raetskii, V. M.; Votinov, S. N. Fiz. Metal. Metalloved.; 29: 284-90(Feb 1970). (In Russian).

Effects of neutron flux (E ≥ 1 MeV) and temperature on the yield of nickel- and iron-base alloys were investigated. The maximum yield was reached at 70°C and irradiation with neutron flux of (2 to 4) × 10^{21} n/cm^2. Results of tests made at T > 20° indicated the existence of stepwise return to the conditional maximum yield at T ≈ 450 to 600°C. Tests at 350°C after irradiation at 70°C showed weakening of the alloy related to the increased vacancies (appearing during disintegration of polyvacancies). (R.V.J.)

42168 RADIATION STABILITY OF PRECISION ALLOYS. Artsishevskii, M. A. Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met., No. 71, 69-75(1969). (In Russian).

It was established that, in contrast to pure metals, changing of physical properties during the irradiation of alloys is connected not with the formation of defects, but with the changing of the structural state. Analysis of the results of experiments made it possible to reveal the laws governing the changes of properties and to evaluate the radiation stability under various radiation conditions. (JPRS)

42169 RADIATION GROWTH OF URANIUM AT LOW BURNUPS. Konobeevskii, S. T.; Panteleev, L. D.; Levitskii, B. M.; Naskidashvili, I. A. At. Energ. (USSR); 28: 326-32(Apr 1970). (In Russian).

The radiation growth of uranium was investigated at two irradiation temperatures: minus 150°C where thermal activation of defects occurring during radiation is low; and 160°C, where thermal activation was significant. The uranium was in various initial states: cold-deformed (80% deformation), slightly annealed at a temperature of 250°C, average annealed at temperatures of 400 and 450°C, and highly annealed (recrystallized) at temperatures of 500 and 620°C. The method of continuously measuring the deformation of the irradiated samples in the interval from 10^{-5} to 10^{-4} deformation was based on the use of two isotopes of uranium combined into a disk by hot rolling. One side contained natural uranium, and the other side of the disk contained 1.5 wt % U-235. Moderate annealing at 250°C led in an increase in the growth of uranium at low irradiation doses. Decreasing the irradiation temperature from 160 to minus 150°C significantly increased the rate of radiation growth in textured uranium with the growth rate depending on the initial state. Annealed samples which did not undergo recrystallization showed an initial non-linear growth rate which increased with increasing annealing temperature, but the linear part of the growth rate decreased to give a smaller overall effect for the more highly annealed samples at higher irradiations. The radiation growth of uranium was considerably lower in the recrystallized samples annealed at 500 and 620°C. These results can be explained by the occurrence of homogeneous defects in the initial metal and as a consequence of the irradiation. (TTT)

42170 RADIATION HARDENING IN VANADIUM. Smolik, G. R.; Chen, C. W. (Ames Lab., Iowa). J. Nucl. Mater.; 35: 94-101(Apr 1970).

The effects of neutron irradiation on the tensile properties of 99.9 wt % pure vanadium were investigated in the fluence range 8×10^{17} to 4×10^{19} n/cm^{-2} (E > 1 MeV). Vanadium was shown to display typical radiation and anneal hardening like other body-centered cubic (bcc) transition metals. However, unlike that seen in Fe, Mo, and W, radiation hardening in V was not accompanied by embrittlement and did not show a tendency to saturation in this fluence range. The radiation hardening effects began to anneal out at 400°C. A nearly complete recovery of the stress-strain curve occurred at 800°C. Possible mechanisms leading to hardening and recovery are discussed. (auth)

42171 PROPERTIES OF IRRADIATED BERYLLIUM. Komienko, L. A.; Papimov, I. I.; Tikhinskii, G. F.; Davidenko, A. S. At. Energ. (USSR); 28: 155-7(1970). (In Russian).

The effect of the grain size and the amount of beryllium oxide in hot-pressed beryllium on its radiation resistance was investigated. The test specimens were prepared from powdered beryllium with an average grain size of 120 and 25 μ, ground from the solid metal under argon; additional beryllium oxide was introduced by oxidizing the powder in an argon-oxygen mixture. The hot-pressed specimens were irradiated by an integral fast-neutron flux of 1.2×10^{20} n/cm^2 at 280°C and were annealed at 600, 850, and 1000°C for 1 hour. The density, Vickers hardness, and compressive strength of the irradiated materials were determined. The data indicated that the material containing the largest amount of beryllium oxide exhibited the highest stability with respect to swelling. This is attributed to the retention of gases by the pores and by the BeO inclusions. Reduction of the grain size resulted in an increase of the radiation resistance, due to the increase of the grain boundary and their decreased penetrability. (TTT)

42172 NATURE OF FAULTS FORMED IN ASSOCIATION WITH VOIDS IN AISI 316 STAINLESS STEEL DURING 20 MeV C^{++} ION BOMBARDMENT. Mazey, D. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 35: 66-6(Apr 1970).

Recent observations showed that small voids resulting from the condensation of vacancies were formed in AISI 316 stainless steel which was subjected to fast neutron irradiation to doses $\gtrsim 1 \times 10^{22}$ nvt, or energetic ion bombardment at temperatures between 400 and 650°C. Large planar defects on {111} planes which exhibited stacking fault fringe contrast were formed concurrently with voids, and these faults were thought to result from the clustering of displaced interstitial atoms. An electron microscope analysis of the nature of similar faults which were produced in 316 steel during bombardment at 550°C with 20 MeV C^{2+} ions is described. These faults were found to have a Burgers vector of the type a/3 ⟨111⟩, and analysis of the contrast at the partial dislocation surrounding the fault in the $|gb| = \frac{2}{3}$ ($w \gtrsim 1$) condition showed the sense of the Burgers vector to be consistent with that of an interstitial Frank loop. (auth)

42173 EFFECT OF FISSION-FRAGMENT IRRADIATION UPON THE OXIDATION OF A 15% Cr/4% Al/86% Y FERRITIC STEEL BY OXYGEN AT 650 AND 800°C. Bennett, M. J.; Chaffey, G. H.; Antill, J. E. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 36: 48-60(Jul 1970).

The oxidation of a 15 wt % Cr/4 wt % Al/0.86% Y ferritic stainless steel by oxygen at 650 and 800°C was studied during fission-fragment irradiation. The exposure period varied up to 5889 hr and the fission-fragment flux was between 1.34 and 1.78×10^9 ff/cm^2 · sec. At 650°C fission-fragment irradiation was without influence on the oxidation behavior. At the higher temperature, however, the extent of oxidation was reduced by fission recoil bombardment but was unaffected by the associated reactor radiations. The factor by which attack was reduced increased with exposure from between 1.5 and 3.2 after 1200 hr to between 2.9 and 4.5 after 4000 hr. The nucleation and growth of a more protective oxide film during fission recoil bombardment could have resulted either from the displacement damage per se or the associated chemical contamination of the oxide film by uranium oxides and fission products. However, simulation out-of-reactor experiments demonstrated that a UO_2 layer reduced the subsequent attack of the steel by oxygen at 800°C to a degree which could fully account for the radiation effect. (auth)

42174 EFFECT OF EXTENSION RATE AND NEUTRON IRRADIATION ON THE TENSILE PROPERTIES OF AN 80/20 NICHROME ALLOY AT ELEVATED TEMPERATURES. El-Shanshoury, I. A.; Gadallah, F. I. (Atomic Energy Establishment, Cairo). J. Nucl. Mater.; 36: 87-93(Jul 1970).

The effect of extension rate (0.11 to 80 mm/min) and neutron irradiation (7×10^{17} to 8×10^{15} n_f/cm^2 and 2×10^{18} to 2.2×10^{16} n_{th}/cm^2) on the elevated temperature mechanical properties of 80% Ni alloy was studied. It was found that the investigated materials were prone to embrittlement even before irradiation. For unirradiated material, the temperature at which the ductility started to decrease and that corresponding to the ductility minimum were dependent on the extension rate. These values were 450, 700°C and 600, 800°C for extension rates of 0.11 and 80 mm/min, respectively. Moreover, the value of the ductility at the minimum was increased by an order of magnitude for the higher value of extension rate. Similar results were obtained for the irradiated material. An explanation for the observed phenomena was suggested on the basis of a vacancy diffusion mechanism. (auth)

42175 HETEROGENEOUS DISTRIBUTION OF IRRADIATION VOIDS IN IRON. Farrell, K.; Houston, J.T. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater.; 35: 352-5(Jun 1970).

One iron specimen was irradiated to a fast neutron fluence of 1.5×10^{21} neutrons/cm^2. A second specimen was heated to 400°C to simulate the in-reactor heating. Partial recrystallization occurred in both specimens. No voids or dislocation loops were found in the unirradiated specimen. Two types of heterogeneous void distributions were apparent in the irradiated iron specimen but no readily resolvable loops. The first of these occurred in the recrystallized regions of the specimen only and the second type of void distribution was evident in the partition of voids between recrystallized and non-recrystallized regions. (G.M.C.)

Ceramics and Cermets

42176 (DP-Report-279) A BRIEF DESCRIPTION OF METALLOGRAPHIC LABORATORY PRACTICE IN THE DRAGON PROJECT. Project DRAGON. Conde, J. F. G.; Keegan, P. (Atomic Energy Establishment, Winfrith (England)). Jun 1964. 39p. Dep. CFSTI.

The metallographic laboratory practice employed in the Dragon Project is described together with the techniques used for the wide range of materials which are subjected to metallography. Typical microstructures of metallic materials, nuclear fuel materials, graphite, and pyrolytic carbon are described and points of interest are noted. (auth)

Corrosion and Erosion

Refer also to abstracts 41391, 42053, 42058, and 43756.

42177 (DP-Report-130) THE CORROSION OF GRAPHITE IN AN H.T.G.R. Project DRAGON. Pointud, M. L.; Valette, L.; de Bruijn, H. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 23p. (CONF-630103-20). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

It is shown that corrosion of porous graphite by carbon dioxide occurs throughout the interior at temperatures up to 1100°C, and that in general the corrosion rate increased with burn-off. Small amounts of barium and strontium are shown to act as catalysts for the graphite-water reaction while small amounts of silica inhibit these effects. Nickel was found to be a powerful catalyst for the graphite-water reaction. Vanadium introduced during graphite production gave rise to pitting corrosion, purification of the graphite by treatment with chlorine at 1000°C reduced this effect. It is suggested that the fuel element graphite may be protected by insertion at the entrance of the purge stream of very reactive graphite impregnated with nickel. (auth)

42178 (DP-Report-372) BASIC STUDIES ON THE CATALYSIS OF OXIDATION REACTIONS OF GRAPHITE. Annual Report No. 2. Project DRAGON. Lothe, Johan; Melsom, Sigurd (Central Inst. for Industrial Research, Blindern (Norway)). Aug 1965. Contract CON/WIN/52327. 69p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, England.

Data were obtained using spectroscopically pure graphite powder (SP1). A gravimetric technique was employed, and the experiments were carried out in a flow reactor. The work concentrated on the catalysis by iron using water vapor as oxidant. Iron was found to be a strong catalyst, and the data indicate that a reduced form of iron is the active catalyst. The catalyst was deactivated at high water vapor pressures, and the data are consistent with a conversion of the active catalyst (metal or carbide) to the less active oxide. Additional data obtained at different temperatures with constant water vapor pressure, show that the catalyst was deactivated at temperatures above 850°C. Hydrogen increased the activity of the catalyst, whereas the rate of reaction was rather insensible to addition of carbon monoxide. The effect of adding silicon to the graphite was investigated, but no significant inhibiting effect on the Fe catalyst could be established. (auth)

42179 (DP-Report-395) THE CORROSION BEHAVIOUR OF COATED FUEL PARTICLES. Project DRAGON. Pollitt, N.

(Atomic Energy Establishment, Winfrith (England)). Jun 1968. 74p. Dep. CFSTI.

An attempt was made to assess the corrosion behavior of a number of experimental batches of coated fuel particles, by subjecting them to oxidation in an atmosphere of argon containing carefully controlled amounts of water vapor at 1000°C. The extent of the damage to the particles was noted using a low powered stereomicroscope. In some instances metallographic examination was also carried out. By these means it was possible to compare the behavior of the various batches qualitatively, and to some extent quantitatively. It was found that, in general, the particles were remarkably resistant to oxidation at this temperature. Eventually the pyrocarbon (PyC) coating did succumb to attack and penetration by the water vapor, resulting in either, the destruction of the particle from within — by rupture of the kernel, or progressive destruction of the outer coating — shown by roughening and finally deep pitting of the PyC surface. In the case of particles having a SiC layer in the coating, no internal damage to the kernel was observed even after the most prolonged exposure to severe oxidizing conditions (more than 300×10^4 microatmosphere hours water vapor), and the SiC appeared to be a most effective barrier to the water vapor. An attempt was also made to correlate corrosion behavior with a specific, mechanical, physical, or chemical property of the coating. Unfortunately it has not proved possible to identify the relevant parameter, and it is considered that a much more detailed study of the deposited PyC structure is necessary. (auth)

42180 EFFECT OF SUBSTITUTIONAL BORON ON THE KINETICS OF THE CARBON–OXYGEN REACTION. Allardice, D. J.; Walker, P. L. Jr. (Pennsylvania State Univ., University Park). Carbon; 8: 375-85(Jun 1970).

Natural graphite flakes were doped substitutionally with boron at six concentrations between 6×10^{-6} and 10^{-2} B/C atom ratios. The reactivity of these graphites and of the undoped material with dry and moist O_2 was studied as a function of temperature (550 to 650°C), carbon burn-off, O_2 pressure, and pre-treatment in water at 625°C. Boronation lowers the rate of carbon gasification in both dry and moist O_2, despite the fact that it also lowers the activation energy of the reaction. However, boronation also lowers the pre-exponential factor in the Arrhenius expression, apparently because of the formation of liquid B_2O_3 and possibly HBO_2 (in moist O_2) which blocks active sites on the graphite surface. This conclusion is supported by a continuous decrease in specific BET surface area of the graphite at burn-offs above about 10%. The decrease in activation energy of gasification with increasing boronation parallels qualitatively the effect of boronation in lowering the Fermi level of graphite. It is suggested that this correlation supports clearly, for the first time, the Long and Sykes concept that electron transfer between the graphite and an impurity can be important in affecting the rate of gasification of the graphite by an oxidizing gas. (auth) (UK)

42181 STUDIES ON A NEW ORDERED OXIDE OF URANIUM AND YTTRIUM. Bartram, S. F.; Fitzsimmons, E. S. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. J. Nucl. Mater.; 35: 126-30(Apr 1970).

During studies on the effects of Y_2O_3 additions to UO_2, the mode of oxidation in air of these solid solutions at 22 to 700°C was carefully followed by x-ray and chemical analyses. A new orthorhombic compound formed during the oxidation of the 10 wt % Y_2O_3 sample. X-ray diffraction data indicated that the ideal composition of the orthorhombic phase was UYO_4, in which the O/U ratio was 2.50. (G.M.C.)

42182 SURFACE-CONTROLLED OXIDATION-REDUCTION OF UO_2. Carter, R. E.; Lay, K. W. (General Electric Research and Development Center, Schenectady, N. Y.). J. Nucl. Mater.; 36: 77-86(Jul 1970).

The oxidation and reduction rates of UO_2 in CO_2-CO mixtures were measured between 900 and 1400°C and O/U ratios of 2.01 and 2.14. A statistically significant stoichiometry gradient within the UO_2 was never found on sectioning mercury quenched specimens. The oxidation rates were proportional to the surface: volume ratio of the specimens and to the (CO_2 + CO) partial pressure in a (CO_2 + CO + inert gas) atmosphere. In CO_2-CO the oxidation within the single phase field is, therefore, controlled by the solid-gas interface reaction. The reduction kinetics could not be so interpreted. An O/U gradient was never found, but the reduction rates with increasing inert gas concentrations and increasing sample sizes were too rapid to be surface-controlled. From sectioning experiments a lower limit was determined for the chemical oxygen diffusion coefficient which was in agreement with that calculated from the oxygen self-diffusion coefficient. (auth)

42183 AIR-OXIDATION OF UO_2 PELLETS AT 800 AND 900°C. Iwasaki, Matae; Ishikawa, Niro (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 36: 116-19(Jul 1970).

The oxidation of UO_2 pellets proceeded by two steps at 800 and 900°C; the first step, $UO_2 \rightarrow (UO_{2+x}) \rightarrow U_4O_9$ and the second step, $U_4O_9 \rightarrow U_3O_8$. The first step reaction proceeded from the surface into the inner layers of pellets, and the reaction rate appeared to be controlled by the diffusion of oxygen through the U_4O_9 phase. The second step reaction, which proceeded rapidly with breaking of the pellet into small pieces, seemed to be initiated by the nucleation of U_3O_8 in the U_4O_9 phase. (auth)

42184 REACTIVITY OF CARBON: SOME CURRENT PROBLEMS AND TRENDS. Thomas, J. M. (University Coll. of Wales, Aberystwyth). Carbon; 8: 249-57(Jun 1970).

The facts and theories which are generally accepted are reviewed with particular attention being paid both to the phenomenological aspects of surface oxide formation and decomposition, and to the occurrence of maxima in Arrhenius plots at elevated temperatures. There is an obvious need to extend present theories, which are capable of offering a unified interpretation of the C + CO_2 and C + H_2O reactions, to encompass the C + O_2 system. The problems relating to reactivity, which have been solved by, and the fresh challenges that have emerged from, the techniques of optical and electron microscopy are summarized. Several unsolved problems are brought into focus, and ways of tackling future studies are discussed by reference to a variety of new techniques. (auth) (UK)

42185 INVESTIGATION OF THE DESTRUCTION OF ALUMINOSILICATE REFRACTORIES WHICH CONTAIN BORON NITRIDE. Gogotsi, G. A.; Kuriat, R. I.; Terekhovskii, B. I.; Tresvyatskii, S. G. (Inst. of Problems of Strength, Kiev. Inst. of Problems in the Science of Materials, Kiev). Probl. Prochnosti; No. 3, 47-50(Mar 1970). (In Russian).

Specimens of complex aluminosilicates containing boron nitride were studied under thermal loading conditions up to 2500°C to determine the characteristics of crack formation and destruction of these refractory materials. To register the temperature during testing, special thermometric specimens with built-in thermocouples were made. The times of fracture were determined by current-conducting pickups. It was found that compositions containing 40 to 50% boron nitride are most resistant to thermal loading. When the boron nitride concentration was high (60% or more) the fracture of the cylindrical specimens was characterized by both radial and annular cracks. Analysis of the fractured surfaces revealed that the ability of these materials to withstand thermal loading depends to a considerable extent on the distance between corundum grains and the uniformity of their distribution. It was found that a refractory material which withstands extreme temperature differentials may be produced by proper selection of the ratio of components — refractory clay, corundum and a certain amount of boron nitride. (JPRS)

Preparation and Fabrication

Refer also to abstracts 41395, 41569, 41601, 41612, 43691, 43694, and 43751.

42186 (DP-Report-127(Pt.1)) THE PREPARATION OF HIGH DENSITY GRAPHITE USING CARBON BLACK. Serial Report No. 203. Project DRAGON. Cornuault, P. (Compagnie Pechiney, Chedde (France)). 1962. 31p. (CONF-630103–10). Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng. From Fuel Element Symposium, Bournemouth, Eng.

A study was made to define the conditions necessary for the production of graphite blocks with good texture and an apparent density as high as possible, of the order of 1.90 to 1.95, for the reflector of the Dragon reactor. The work was done in the laboratory, experiments at the pilot plant stage were only roughly drafted out. Suitable products were obtained using graphite as a base material with carbon black. (auth)

42187 (DP-Report-127(Pt.2)) PREPARATION OF HIGH DENSITY GRAPHITE USING CARBON BLACK. Project DRAGON. Cornuault, P. (Compagnie Pechiney, Chedde (France)). Jan 1963. 94p. (In French). (CONF-630103–11). Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng. From Fuel Element Symposium, Bournemouth, Eng.

Part II contains the appendices listed below: raw materials used; method of preparation; the influence of the grain size of the graphite fraction; effect of the carbon black content; replacement of the carbon black with micronized graphite; improvement in homogeneity of the paste; and the discontinuance of the complementary baking at 900°C before impregnation in the case of products baked under pressure at 550°C. (auth)

42188 (DP-Report-133) A BASIC STUDY OF THE THORIUM–URANIUM–CARBON SYSTEM. Project DRAGON. Marchal, M.; Accary, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan 1963. 88p. (CONF-630103-19). Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng. From Fuel Element Symposium, Bournemouth, Eng.

The proportion of samples of mixed uranium–thorium monocarbides and dicarbides by reaction sintering, and the interaction of the mixed carbides with graphite were studied. The behavior and possibility of failure of the coated particles under conditions of isothermal heat treatment, thermal cycling, and thermal gradient were investigated. (auth)

42189 (DP-Report-134) DEVELOPMENT WORK ON CARBIDE FUEL PARTICLES. Project DRAGON. Bildstein, H.; Koss, P.; Rudy, E. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna. Metallwerk Plansee, Reutte/Tyrol (Austria)). Jan 1963. 30p. (CONF-630103-6). Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng. From Fuel Element Symposium, Bournemouth, Eng.

A review of the existing methods for the production of fuel material of the type $(U,Th)C_2$ and (U,Zr)C and of the possibilities of spheroidization of these materials is presented and procedures are described leading to molten spherical particles in the size range between 100 and 500μ. According to the experimental results preference was finally given to formation of the mixed carbides by a solid state reaction, comminution to fine powder, agglomeration in a centrifugal sieve to the required size and spheroidization by melting. (auth)

42190 (DP-Report-139) STUDIES ON COATED PARTICLE FUEL INVOLVING COATING, CONSOLIDATION, AND EVALUATION. PARTS 1-6. Project DRAGON. Bickerdike, R. L.; Ranson, H. C.; Vivante, C.; Hughes, G. (Royal Aircraft Establishment, Farnborough (England)). Jan 1963. 89p. (CONF-630103-5). Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng. From Fuel Element Symposium, Bournemouth, Eng.

The development of a high-temperature fluidization apparatus for the deposition of carbon on spherical uranium carbide particles is described. The results of stability, porosity, compatibility and other measurements are tabulated. The deposition of a silicon carbide layer as an alternative to carbon is described: details of a production furnace and of an investigation into the properties of the silicon carbide layer are also given. (auth)

42191 (DP-Report-140) DEVELOPMENT OF PRODUCTION SCALE PROCEDURES FOR COATING FUEL PARTICLES. Project DRAGON. Rudy, E.; Benesovsky, Fr.; Pohler, A. (Metallwerk Plansee, Reutte/Tyrol (Austria)). Jan 1963. 23p. (CONF-630103-22). Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng. From Fuel Element Symposium, Bournemouth, Eng.

Work is described on fluidized-bed processes for the pyrolytic deposition of carbon coatings onto fuel particles. (auth)

42192 (DP-Report-146) THE FUEL ELEMENT GRAPHITE. Project DRAGON. Graham, L. W.; Price, M. S. T. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 115p. (CONF-630103-13). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

A review of the development work carried out in an attempt to produce highly impermeable graphite for the Dragon reactor fuel tubes by impregnation of a commercially available graphite with furfuryl alcohol is given. Data on the techniques of impregnation, fission product diffusion, degassing, mechanical and physical properties, and radiation effects for the graphite being manufactured for the first fuel charge are given. (auth)

42193 (DP-Report-147) FORMING OF REFRACTORY SPHEROIDS. PART II. Project DRAGON. Sturge, D. W.; Smyth, R. T. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 22p. (CONF-630103-23). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

The passage of $(UTh)C_2$ particles through a high temperature plasma arc furnace to produce melted spherical particles is described. Manufacturing drawings and operating instructions are included. (auth)

42194 (DP-Report-149) FABRICATION OF SPHEROIDIZED PARTICLES BY THE POWDER METALLURGY AGGLOMERATION PROCESS. Project DRAGON. Gorle, F.; Jonckheere, E.; Vangeel, J. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Jan 1963. 12p. (CONF-630103-14). Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, England.

From Fuel Element Symposium, Bournemouth, England.

The application of the powder metallurgy agglomeration process to the fabrication of mixed carbides of zirconium and uranium is described. Initial tests on the fabrication of particles of the mixed carbides of thorium and uranium are described and the possibility of fabricating a fuel based on the mixed oxides of thorium and uranium is considered. (auth)

42195 (DP-Report-151(Pt.1)) DEVELOPMENT OF COATED PARTICLE FUEL. PART I. THE FISSILE FERTILE PARTICLE. Project DRAGON. Burnett, R. C.; Bisdorff, L.; Gough, J. R. C. (Atomic Energy Establishment, Winfrith (England)). Jan. 1963. 45p. (CONF-630103-8). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

Following the development of a process for the preparation of spherical particles of uranium oxide, and subsequent adaptation of the process to carbide fuel particles, investigations were carried out to determine the production route. Each stage of the proposed production process was evaluated in detail. Considerable information was derived from the preparation of fuel specimens for irradiation, particularly as regards process efficiencies and the characteristics of the fuel particle. Although the work was mainly concentrated on the thorium carbide–uranium carbide fuel particle a limited amount of process data was obtained for zirconium containing fuel. (auth)

42196 (DP-Report-151(Pt.2)) DEVELOPMENT OF COATED PARTICLE FUEL. PART II. COATING AND CONSOLIDATION. Project DRAGON. Beutler, H.; Redding, G. B.; Gough, J. R. C. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 25p. (CONF-630103-4). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

The development of the technique of coating fuel particles with pyrolytic carbon and silicon carbide is described. Evaluation studies include an investigation of the variation of coating thickness with particle size and of deposition rate with batch size. Experience of operating the prototype production scale fluidized bed showed the need for some design modifications. The technique used for consolidating coated fuel particles into graphitic-matrix fuel bodies is described in detail. (auth)

42197 (DP-Report-292) THE DEVELOPMENT OF THE PRODUCTION PROCESS FOR THE FABRICATION OF THE ZIRCONIUM/URANIUM MONOCARBIDE FUEL KERNELS FOR THE FIRST CHARGE OF THE DRAGON REACTOR. Project DRAGON. Horsley, G. W.; Hankart, L. J. (Atomic Energy Establishment, Winfrith (England)). Aug 1964. 62p. Dep. CFSTI.

The development of a method of producing sintered porous kernels of uranium monocarbide/zirconium carbide solid solution containing a quantity of free carbon from uranium metal powder, zirconium carbide powder, and carbon black is described. This work has involved study of: the preparation of uranium monocarbide powder; the preparation of uranium monocarbide/zirconium carbide/carbon powder mixtures; the preparation of green kernels of the UC/ZrC/C mixture using the rotary sieving technique and liquid paraffins as binders; the sintering of UC/ZrC/C kernels; and the overall efficiency of the process. (auth)

42198 (DP-Report-302) A COMPARISON OF THE POWDER CASTING AND HOT PRESSING ROUTES FOR THE PREPARATION OF DRAGON FUEL INSERTS. Project DRAGON. Savage, D. W.; Redding, G. B.; Williams, G. (Atomic Energy Establishment, Winfrith (England)). Nov 1964. 25p. Dep. CFSTI.

The powder casting and hot pressing method for the consolidation of pyrolytic carbon-coated fuel particles in a graphite matrix was compared in terms of fuel insert properties, fuel dispersion, and damage to fuel particle coatings. The hot pressing method gives fuel with the highest matrix density. Also, at 10 volume % fuel loading, inserts prepared by the hot pressing method have a significantly higher radial thermal conductivity, at the operating temperature of an HTR, than corresponding inserts prepared by the powder casting method. Although hot pressing gives a lower permeability matrix, powder casting gives a stronger insert. The differences in matrix properties can be explained in terms of the matrix density, the proportion of fully graphitized filler in the matrix and the type of binder carbon. For both methods, the homogeneity of the fuel dispersion as measured qualitatively by radiographic examination appeared to be satisfactory. Tests showed that particle breakage had not occurred to any greater extent in the particles consolidated by the hot pressing employing 4,000 psi applied pressure, than in particles consolidated by powder casting employing only a light molding pressure. (auth)

42199 (DP-Report-304) IMPREGNATION OF GRAPHITE SPECIMENS USING THE FURFURYL ALCOHOL IMPREGNATION PROCESS. Project DRAGON. Martina, R. A.; Vohler, O. J.

(Sigri-Kohlenfabrikate G.m.b.H., Meitingen (West Germany)). Nov 1964. 110p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

Results of the furfuryl alcohol impregnation treatment of graphite fuel rods and end plugs are reported. On impregnating the components two and three times, the permeability decreased, starting from a coefficient of about 5×10^{-2} cm^2 sec^{-1} to a value of 10^{-6} to 10^{-7} cm^2 sec^{-1}. The rejects as occurred with the first batches were finally diminished to a negligible amount by studying the single steps of treatment. (auth)

42200 (DP-Report-394) BASIC STUDIES ON THE GROWTH OF CARBON DEPOSITION FROM CARBON MONOXIDE ON A METAL CATALYST. First Annual Report, March 1, 1964–February 28, 1965. Project DRAGON. Ruston, W. R.; Warzee, M.; Hannaut, J.; Waty, J. (Atomic Energy Establishment, Winfrith (England)). 21 Jun 1965. 49p. (CONF-660318-5). Dep. CFSTI.

From Dragon Contractors' Research and Development Symposium, Harwell, Eng.

The catalytic decomposition of carbon monoxide on iron surfaces at 550°C was studied by metallography, internal friction measurements, x-ray diffraction, and electron microscopy. Carbonization of the bulk of the metal takes place by interstitial diffusion of carbon atoms with precipitation of cementite when the solution becomes supersaturated; this affects the mechanical stability of the metal. Carbon grows from the surface of the metal in two forms. The first is a lamellar form arising from decomposition of Fe_3C crystals in the surface. The second is a whisker form which originates from the epitaxial growth of small crystals of a particular iron carbide on the surface of metal grains and Fe_3C crystals. X-ray diffraction studies show this iron carbide to be Fe_7C_3. Electron microscopy of the carbon whiskers shows a small crystal of Fe_7C_3 which acts as a growth center within each whisker. (auth)

42201 (DP-Report-399) REPORT ON RESEARCH INTO THE SOL-GEL PROCESS OF PREPARING CARBIDE FUEL PARTICLES. Interim Report on CON/WIN/52340, July 1, 1964–July 1, 1965. Project DRAGON. Van Der Plas, Th.; Hermans, M. E. A. (Keuring van Electrotechnische Materialen, N. V., Arnhem (Netherlands)). Jan 1966. 12p. (CONF-660318-6). Dep. CFSTI.

For Atomic Energy Establishment, Winfrith (England). From Dragon Contractors' Research and Development Symposium, Harwell, Eng.

Further development work on the sol-gel process is described. No major changes in the process have been found necessary, but a number of details were studied. The influence of urea on the gelation time of sols and the preparation of dense oxide particles were considered. Also studied were the preparation of sols from nitrates by reduction with formic acid and the preparation of sols from mixed thorium–uranium nitrate solutions. (auth)

42202 (DP-Report-407) COMPUTATION OF SOME CHARACTERISTICS OF PYROCARBON LAYERS DEPOSITED ON FUEL PARTICLES FROM COATING PROCESS MEASUREMENTS. Project DRAGON. Lanaspeze, P.; Schniewind, J. (Atomic Energy Establishment, Winfrith (England)). Feb 1966. 52p. Dep. CFSTI.

A computer program has been developed to investigate the continuous variations of density throughout the pyrocarbon layer deposited on fuel particles. This program can also be used to define an accurate histogram of density of the various types of pyrocarbon which constitute the layer. Routine measurements required include the mean diameter, and the bulk density of the pyrocarbon layer of six or seven small samples of not fully coated particles extracted from the fluidized bed during the coating process. The reliability of this analytical method is checked against experimentally measured histograms of density in the cases of typical pyrocarbon coatings such as high density, low-temperature deposited; low density, medium-temperature deposited; and high density, high-temperature deposited. The analytical method has proved realistic. (auth)

42203 (IFA-MN-10) CONSIDERATIONS ABOUT SYNTHESIS AND SINTERING OF NUCLEAR CERAMIC FUELS (UO_2 AND UC). Mirion, I.; Gutu, A.; Demetrescu, S.; Jitea, I. (Institutul de Fizica Atomica, Bucharest (Romania)). 1970. 9p. Dep. CFSTI (U. S. Sales Only).

Research was centered on the synthesis and sintering of nuclear ceramic fuels at a temperature as low as possible. The investigations led to a method for uranium dioxide powder preparation, pressing, and sintering by which a 10.4 g/cm^2 minimal density for samples is usually achieved. The sintering temperature is maintained at 1350°C for 4.5 hours. The uranium carbide synthesis was achieved through a carboreduction of uranium salts [illegible]. Uranium monocarbide was obtained at a ratio of 93% after a hydrogen retreatment at 1450°C. The density of the reacted pellets ranged from 10.7 to 11.4 g/cm^2. (auth)

42204 (NP-10334) FABRICATION OF COMPONENTS FOR THORIUM DOPPLER COEFFICIENT MEASUREMENTS IN THE GENERAL ATOMIC CRITICAL ASSEMBLY. Project DRAGON. Gough, J. R. C.; Redding, G. B.; Burnett, R. C. (Atomic Energy Establishment, Winfrith (England)). May 1961. 30p. (DP-Report-29). Dep. CFSTI.

Thorium-bearing components were fabricated for Doppler broadening experiments in the General Atomic critical assembly. Results showed the size variations to be expected in production batches of fuel inserts. It was found that under oxidizing conditions the inserts undergo a considerable expansion which is followed by a subsequent reduction in both length and diameter. (auth)

42205 (NP-10479) THE MANUFACTURE AND PORE PROPERTIES OF A SERIES OF FINE-GRAINED GRAPHITES. Project DRAGON. Jenkins, T. R.; Longstaff, B. (Atomic Energy Establishment, Winfrith (England)). Jul 1961. 37p. (DP-Report-47). Dep. CFSTI.

Experimental work to develop fine grained, high-density graphites of consistent quality, sufficiently impermeable for use in the Dragon reactor, is described. The information obtained will act as a guide for the manufacturer, thus reducing to a minimum the development work necessary to produce a similar product using his own raw materials and equipment. (auth)

42206 (NP-10941) FORMING OF REFRACTORY SPHEROIDS BY PLASMA JET AND THE DEVELOPMENT OF A PLASMA FURNACE. PART I. Project DRAGON. Sturge, D. W.; Smyth, R. T. (Atomic Energy Establishment, Winfrith (England)). Oct 1961. 15p. (DP-Report-56). Dep. CFSTI.

The passage of particulate materials through a high temperature plasma jet in an attempt to form spheroids is described. The particle dwell time in the plasma is too short; a new approach by the development of a plasma furnace is discussed. (auth)

42207 POLYMORPHISM OF THE SESQUIOXIDES OF THE RARE EARTHS. II. PRECIPITATION OF RARE EARTH OXIDES FROM MOLTEN NITRATES. Brauer, G.; Siegert, A. (Univ., Freiburg i. B.). Z. Anorg. Allg. Chem.; 371: 263-73(Dec 1969). (In German).

Rare earth oxides were precipitated by thermal decomposition of fused mixtures of sodium nitrate, potassium nitrate, and one rare earth nitrate. At 430°C the following oxide modifications were precipitated: B-Sm_2O_3, B-Eu_2O_3, B-Gd_2O_3, and C-type oxides of Dy through Lu. A-Nd_2O_3 formed at 550°C, A-La_2O_3 at 650°C. This gives evidence that the observed modifications are more stable than other polymorphs of the respective oxides, even at lower temperatures. (auth)

42208 HOT-PRESSING OF TANTALUM CARBIDE. I. SINTERING IN THE BINARY SYSTEM OF TaC–ZrC. Matsuo, Shigetomo; Horie, Michihiko; Jumi, Yoshio (Niigata Univ., Nagaoka, Japan). Funtai Oyobi Funmatsuyakin; 17: No. 1, 19-24(Jun 1970). (In Japanese).

Carbides of Groups IVb, Vb, and VIb metals have high melting point, high hardness, and good electrical conductivity as well as good thermionic emissivity. Moreover, they exhibit high mechanical strength at elevated temperatures. Among these, ZrC, HfC, TaC, and their solid solutions are important as high temperature materials because of their high melting points. But, since they have poor sinterability, few precise details are known about the powdered mixture or solid solution. A series of studies on TaC base materials for incandescent filaments aimed at development of sintered materials resistant against thermal shock is reported. The sintering properties in the binary system TaC–ZrC were studied by using a vacuum hot-pressing apparatus, since it was considered that the acceleration of the densification seems to control the properties, especially the mechanical properties of the sintered material. (auth) (Japan)

42209 CONSOLIDATION OF COATED FUEL PARTICLES WITH PYROLITIC CARBON OR SILICON CARBIDE. Gyarmati, E.; Nickel, H. (Kernforschungsanlage, Juelich, Ger.). Carbon: 8: 400-1(Jun 1970).

A single step process was developed for the consolidation of fuel particles. The process is based on pyrolytic decomposition of gaseous hydrocarbons such as CH_4, CH = CH, C_3H_8, or methylchlorosilanes, such as CH_4SiCl_3 or CH_3SiHCl_2, onto loosely packed coated fuel particles at 1200 to 2000°C. During the pyrolysis the particles are coated and bridges formed in-between cause them to stick together. Heating is by a movable induction coil. (UK)

42210 PREPARATION OF STABLE SOLS OF THORIA-URANIUM [illegible]. [illegible]vey, Albert B. (to United States

Atomic Energy Commission). U. S. Patent 3,513,101. 19 May 1970. Filed 25 Apr 1968.

A ThO_2-UO_3 sol having a minimum of counterions was prepared in a CO_2-free atmosphere by forming a ThO_2-UO_3 seed sol stabilized with a stoichiometric excess of counterion and dispersing additional quantities of counterion-free hydrous ThO_2-UO_3 as a water slurry in the seed sol by boiling to peptize the solids into the sol with a minimum of counterions. The seed sol has a counterion to metal mole ratio of 0:4; but in the final sol the ammonium ion concentration is reduced to 10 to 30 ppM and the nitrate to metal ratio in the final sol is ~0:13. The pH of the sol is 3.9 to 4.3. (B.L.M.)

42211 REACTION OF HYDROGEN WITH NEODYMIUM AT VARIOUS TEMPERATURES. Gayer, K. H.; Grunwald, J. J. (Wayne State Univ., Detroit). Z. Anorg. Allg. Chem.; 368: 327-35(Sep 1969).

The reaction of neodymium with hydrogen was investigated from 100 to 800°C. The predominant portion of the hydrogen is taken up at constant rate. The final saturation with hydrogen is diffusion-controlled and obeys the parabolic laws. A reaction mechanism is proposed in terms of the various phases of reaction displayed by plots of average composition versus time. (auth)

42212 METHOD FOR PREPARING AN OXIDIC FISSILE MATERIAL CONTAINING A METAL BORIDE AS BURNABLE POISON. Versteeg, Geert; Engel, Albertus J. G.; Hamburg, Fokko W. (to Reactor Centrum Nederland Development of Nuclear Science). U. S. Patent 3,520,958. 21 Jul 1970. Filed 5 Oct 1967.

A method of preparing sintered uranium dioxide or plutonium dioxide in mixtures with a metal boride as a burnable poison or resonance absorber is described. A mixture of the granular oxide and the granular metal boride is pressed and then reduced in an atmosphere containing CO to remove most of the excess oxygen which would attack the boride during the subsequent sintering step. (auth)

42213 PROCESS FOR PREPARING MICROSPHERES OF URANIUM, PLUTONIUM, OR THORIUM CARBIDE. Triggiani, Leonard V. (to W. R. Grace and Co.). U. S. Patent 3,518,328. 30 Jun 1970. Filed 21 Mar 1967.

A method is described of preparing actinide carbide microspheres by co-precipitating a solution of the actinide metal and an alkaline dispersion of carbon, followed by peptization thereby forming an actinide oxide sol containing carbon. The sol is then formed into droplets and the droplets gelled by passing through a solvent column. The gelled droplets are washed and sintered to densify into the desired carbide composition. (auth)

42214 RECLAMATION OF LITHIUM ALUMINATE TARGET ELEMENTS. Cooperstein, Raymond (to United States Atomic Energy Commission). U. S. Patent 3,510,270. 5 May 1970. Filed 10 Aug 1967.

Target elements for the production of tritium by neutron irradiation in a nuclear reactor are reclaimed. The target elements comprised sintered pellets of lithium aluminate sealed in aluminum cans. In order to reclaim the pellets, the target elements were heated to a temperature of 675 to 900°C., thereby melting the aluminum, which was drained away from the pellets without affecting the integrity of the pellets. (auth)

42215 DIFFUSION BONDING OF CERAMICS. Sandstrom, Donald J. (to United States Atomic Energy Commission). U. S. Patent 3,517,432. 30 Jun 1970. Filed 2 May 1968.

A method is described for bonding a ceramic to another ceramic body in which a metal such as aluminum, titanium, or vanadium in the form of foil, oxide, or hydride is placed between two ceramic bodies, heated in an oxidizing or inert atmosphere until the metal reacts with the ceramic causing solution of the bonding agent with the ceramic. Upon subsequent cooling to room temperature the bonding material remains as a mixed oxide phase which is a non-conducting ceramic phase which has produced a diffusion bond. (auth)

42216 METHOD FOR PRESSING THIN WALLED BORON NITRIDE ARTICLES UTILIZING A LIQUID NITROGEN PRE-TREATMENT. Asbury, Joseph J. (to United States Atomic Energy Commission). U. S. Patent 3,513,229. 19 May 1970. Filed 16 Aug 1968.

A method of pressing boron nitride particles containing 0 to 77% B_2O_3 into thin walled configurations is described. The desired pressed density of greater than 1.75 gm/cc was achieved by immersing the particles in liquid nitrogen, allowing the particles to warm up to about room temperature to evaporate essentially all of the liquid nitrogen, and then isostatically pressing the particles at about room temperature and about 30,000 psi. A higher density of at least 2.00 gm/cc could be achieved by a further step of hot pressing to 1100 to 1800°C at pressures of 3000 to 5000 psi. (auth)

42217 NEUTRON-ABSORBING GRAPHITIC PRODUCT AND METHOD OF PREPARATION. Cledat, Jean; Moreau, Michel; Rappeneau, Jean (to Commissariat a l'Energie Atomique). U. S. Patent 3,516,948. 23 Jun 1970. Priority date 24 Mar 1967, France.

The process consists in mixing powders of graphite and of boron nitride, dehydrated boron calcite or rare earth metal oxides, adding 15 to 30% of tar by weight, compacting the mass into articles and heating at a temperature of from 1000 to 1200°C (to 1150°C if boron calcite is used) for a time sufficient to coke the tar. (auth)

42218 COPPER/VANADIUM OXIDE COMPOSITIONS. Hoffmann, Lewis C. (to E. I. du Pont de Nemours and Co.). U. S. Patent 3,516,949. 23 Jun 1970. Filed 31 Oct 1967.

Noble metal metalizing compositions are described comprising (a) a noble metal powder, (b) an inorganic binder powder and (c) a V_2O_5 additive powder to improve solderability, and/or adhesion properties of fired coatings on ceramic substrates, components (a), (b) and (c) being present in specified proportions. Electrical conductor elements may also be made using such compositions. The V_2O_5 additive may be a copper/vanadium oxide composition containing Cu_2O and V_2O_5 in specified proportions, which is preferably in a fusion-reacted form. Such copper/vanadium oxide composition may also serve as the inorganic binder in the metalizing composition, although its use in a mixture with a glass powder is preferred. When V_2O_5 per se is used as the additive, it should be employed in a mixture with a glass powder. (auth)

42219 PROCESS FOR PREPARING STOICHIOMETRIC URANIUM DIOXIDE. Triggiani, Leonard Vincent; Stone, Irving Charles (to W. R. Grace and Co.). U. S. Patent 3,518,065. 30 Jun 1970. Filed 23 Apr 1968.

A process for preparing urania microspheres is described. It is useful in producing fuel particles, in which the oxygen to uranium ratio is reduced to 2.0 by passing a reducing gas, such as hydrogen, through the particles at a temperature of about 300 to 800°C and then densifying the particles by sintering at 1050 to 1150°C. (auth)

42220 BORON AND BORON CARBIDE COATINGS BY VAPOR DEPOSITION. Cochran, Andrew A. (Bureau of Mines, Rolla, Mo.); Stephenson, James B.; Donaldson, James G. J. Metals; 22: No. 8, 37-42(Aug 1970).

The Bureau of Mines investigated the formation of boron and boron carbide coatings by vapor phase reactions. Optimum parameters were determined for hydrogen reduction of boron trichloride and for the formation of boron carbide coatings on graphite by reaction with the depositing boron. At 1300°C, about 85% of the boron was deposited. Tungsten substrates did not react with the boron deposit; other substrates reacted to various extents. The hydrogen reduction of boron tribromide was briefly investigated. Boron carbide was deposited at 1300°C by adding methane to the boron trichloride–hydrogen feed gas. The chemical composition of the vapor-deposited boron carbide approximated B_4C. A method of etching B_4C was developed to study its microstructure. When boron was deposited on graphite at 1500°C very hard, uniform, strongly adherent coatings of B_4C were formed that might be useful in applications such as rocket nozzles and chemical reaction and processing vessels. (auth)

42221 SIMULTANEOUS CHEMICAL VAPOUR DEPOSITION OF CARBON AND SILICON. Marinkovic, S.; Suznjevic, C.; Dezarov, I.; Mihajlovic, A.; Cerovic, D. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Carbon; 8: 283-95(Jun 1970).

The simultaneous chemical vapor deposition of C and Si from CH_4-$SiCl_4$ gas mixture at deposition temperatures of 1340 to 1630°C, total pressures of 50 to 200 mm Hg, CH_4 flowrates of 2000 ml/hr and 2 to 75 vol % $SiCl_4$ in the gas mixture, gives products which are essentially C containing up to about 15 wt % Si. The Si content of the deposits decreases with increasing deposition temperature. The presence of the $SiCl_4$ in the gas phase strongly influences the process of deposition, the deposition rate being increased by a factor 4 to 5 compared with that of pure pyrocarbon. From the dependence of preferred orientation, crystallite size, apparent density, rate of oxidation and rapidly oxidized component content on silicon concentration in the product, it was concluded that a substitutional solid solution of silicon in pyrocarbons is formed, the maximum solid solubility being 0.15 to 0.20%. Any Si concentration in excess of this exists as a separate phase, β-SiC. At higher Si concentration in the product (>1.5 to 2%) its microstructure is characterized by presence of very large cones superimposed in a normal pyrocarbon narrow-cone structure.

Results obtained by combining different methods (optical microscopy, microhardness tests, electron probe microanalysis and x-ray investigation) enabled detailed study of the larger cones, which are shown to contain much higher Si concentration (present as SiC) than the narrow cones which are essentially solid solution of Si in pyrocarbon. The total pressure and the deposition temperature have similar effects on the deposition rate and properties of the deposits. (auth) (UK)

42222 RESISTANCE SPOT WELDING OF METAL MATRIX COMPOSITE. Hersh, Michael S. (General Dynamics, San Diego, Calif.). Weld. J.; 49: 254-s-8(Jun 1970).

The quality and strength of spot-welds were greatly affected by the quality of the composite sheets prior to joining. Panels were radiographed and ultrasonically C-scanned to determine material quality. The effectiveness of nondestructive testing and the correlation of these data to resultant spot weld quality is discussed, as well as radiography, ultrasonic inspection, and localized microresistance measurements. These three inspection methods can be combined to characterize the internal composite structure. Broken filaments, disbonds, variations in local filament density, and combinations of these can be discerned. The bulk of the data presented is for one or more layers of 0.020 in. thick, 50 vol. % boron unidirectionally reinforced 6061 aluminum matrix (Al-B), spot welded 0.020 in. thick, 2024-T3 aluminum alloy. The solidus temperature of 2024 was approximately 150°F lower than that of 6061 aluminum, therefore when welding, the nugget fusion will occur at a temperature at which the 2024 is more fluid than the 6061. This requires a significant reduction of the weld and forge pressures to prevent expulsion. Concomitantly, weld heat must also be reduced to prevent gross melting of the 2024 alloy. This results in a smaller weld nugget and reduced cross-tension strength. When the 2024 aluminum was sandwiched between two sheets of composite, the effect of differences in melting points could be adequately compensated for by lowering the heat and pressure and increasing the forge delay. Spot welding of another sheet of Al-B composite to an Al-B/Al/Al-B buildup resulted in a much larger spot diameter, an increase in lap shear strength, and increased indentation. Results of lap shear tests of silicon carbide-coated boron-reinforced aluminum are included. The effect of welding parameters on weld nugget strength and size are illustrated with 0.024 in. 45 vol. % ± 45 deg to load axis, cross-ply reinforced Al-B composite. (auth)

42223 APPARATUS FOR THE PRODUCTION OF URANIUM FLUORIDE. Delange, Maurice; Huet, Henri; Vertes, Paul (to Commissariat a l'Energie Atomique). U. S. Patent 3,518,062. 30 Jun 1970. Priority date 5 Nov 1957, France.

An apparatus to produce uranium fluoride is described in which the uranium oxides UO_3 and U_3O_8 are fed to a vertical reduction reactor. The reduction reactor communicates through a funnel with a vertical hydrofluorination reactor. The active gases in the reactors are prevented from mixing. In the full form of the preferred embodiment, improved performance is achieved by the connection of a horizontal hydrofluorination reactor subsequent to the vertical reactor. (auth)

42224 VIB-SWAGING PROCESS FOR FUEL ROD. Naruki, Kaoru (Power Reactor and Nuclear Fuel Development Corp., Tokai, Japan). J. Nucl. Sci. Technol. (Tokyo); 7: 327-34(Jul 1970).

A series of experiments has been conducted for gaining information to contribute to the vib-swaging process as a practical method for fabricating fuel rods. The present report covers, in particular, observations made on the relationship between the properties of the intermediate compact before swaging and the final swaged product, in respect of bulk density and dimensions. Selection of a suitable pre-swage density and initial cladding tube dimensions is very important for consistently obtaining products of acceptable properties. Equations have been derived to relate quantities representing the dimensions and properties of the compact and cladding tube before and after swaging. These equations should prove useful for estimating the bulk density and wall-thickness of the swaged rod. The reduction ratio per step of swaging should be kept to a level below about 10%. Larger particles in the compact tend to indent the inner surface of the cladding tube during swaging process, and from this standpoint very coarse particles are not desirable. The following conditions for vib-swaging are proposed as suitable for preparing fuel rods of 92% T.D. from fused UO_2 powder (about 99% T.D. particle density). UO_2 powder: less than 14 mesh; Reduction ratio: less than 10% per one step, 22 to 14% for total; Pre-swage density: 81 to 85% T.D. These conditions are also valid for fabricating to JPDR-1 fuel rod specifications. (auth)

42225 PROCESS FOR PREPARING HIGH-DENSITY ISOTROPIC GRAPHITE STRUCTURES. Peterson, George R. (to United States Atomic Energy Commission). U. S. Patent 3,517,092. 23 Jun 1970. Filed 15 Apr 1968.

A high density, isotropic graphite structure comprising essentially 100% graphite is prepared by wet-blending graphite flour having an average particle size no greater than −5μ with pitch, forming an isotropic graphite structure which has a density within the range of 1.70 to 1.95 gms/cc from this admixture, heating the graphite structure in a confining graphite die to an elevated temperature to carbonize the pitch and remove essentially all volatile materials while maintaining the density at a value within the range of 1.70 to 1.95 gms/cc, conducting a series of repetitive steps of impregnating the graphite structure with pitch by isostatic pressing at a pressure of at least 4500 psi at 200°C, heating the impregnated structure while submerged in pitch to an elevated temperature to carbonize the pitch and remove essentially all volatile materials, thereby raising the density of the graphite structure to at least 1.95 gms/cc and thereafter heating the structure to 3000°C, to fully graphitize the structure. (auth)

42226 METHOD OF PREPARING A NITRIDE NUCLEAR REACTOR FUEL. Weber, Edward T.; Greenhalgh, Wilbur O. (to United States Atomic Energy Commission). U. S. Patent 3,510,434. 5 May 1970. Filed 6 Jun 1968.

A process is described for preparing single-phase particles of uranium nitride, plutonium nitride or uranium–plutonium nitride. Very finely divided uranium oxide, plutonium oxide, or a mixture of the two is intimately mixed with finely divided C. The mixture is then reacted with flowing N_2 at a temperature in the range 1500° to 1700°C, until evolution of CO ceases, in a reactor made of a refractory material, e.g., W, which is inert to the reactants. The product is then purified by heating with H_2 at 1000°C to 1200°C to remove free C, heating with N_2 at 1000° to 1200°C to displace combined C from any carbides or carbonitrides, again heating with H_2 to remove the C thus freed, and heating with an inert gas at a temperature of at least 1500°C to decompose any higher nitrides, e.g., U_2N_3, which have been formed. The material is then cooled in a flow of inert gas. The uranium–plutonium nitrides are particularly desirable as fast reactor fuels. (auth)

Properties Evaluations

Refer also to abstracts 41257, 41628, 42109, 42118, 42119, 42121, 43691, 43692, 43694, 43695, and 43857.

42227 (DP-Report-111) DIFFUSION OF GASES IN GRAPHITE PORES. Project DRAGON. Truitt, J.; Evans, R. B., III; Mason, E. A. (Atomic Energy Establishment, Winfrith (England)). Aug 1962. 26p. (CONF-620305-2). Dep. CFSTI.

From Carbon Transfer Discussion Meeting, Dorchester, Dorset, England.

A system of equations was adopted for the diffusion of gases in graphite pores in the absence of temperature and pressure gradients. Portions of the medium are visualized as a collection of fixed "dust" particles that are uniformly distributed. The results apply over the entire pressure range from the Knudsen region to the normal diffusion region. This approach permits a satisfactory explanation of the fact that over wide pressure ranges the flux ratio of two counter-diffusing gases is $(m_2/m_1)^{\frac{1}{2}}$ in porous media under steady-state and uniform-pressure conditions. The effect of nonuniform pressures on the diffusion equations is to introduce both a pressure diffusion term and an external force term. However, the final diffusion equation has the same form as in the uniform pressure case. No additional parameters are required to compute the diffusion rates when pressure gradients are present. A complete solution requires also a forced flow equation giving J (the net flux) as a function of the pressure gradient. A forced flow equation is derived on the basis of the dusty-gas concept, but one parameter must be made disposable in order to compensate for the fact that the diffusion equations permit only a diffusive mechanism for flow, never a viscous mechanism. A series of experiments with one gas mixture is discussed. (auth)

42228 (DP-Report-138) EVALUATION STUDIES ON COATED FUEL PARTICLES AT S.G.A.E., SEIBERSDORF. Project DRAGON. Koss, P.; Bildstein, H.; Proksch, E. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 34p. (CONF-630103-17). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

Methods are described for the evaluation of coated fuel particles including chemical analysis, metrology, metallographic examination, measurement of surface contamination and determination of fission product retention characteristics. Major emphasis was laid upon the xenon and barium release measurements. The lowest

fractional release values obtained after 100 hours at 1500°C with duplex coatings are better than 1×10^{-6} for xenon and better than 1×10^{-3} for barium. (auth)

42229 (DP-Report-295) TESTING AND EVALUATION OF REACTOR FUEL PARTICLES. Project DRAGON. Koss, P.; Bildstein, H. (Atomic Energy Establishment, Winfrith (England)). Sep 1964. 52p. Dep. CFSTI.

The results of tests performed on a large number of experimental particles of different origin are reported. Methods are described for the evaluation of coated fuel particles including chemical analysis, metrology, metallographic examination, measurement of surface contamination, and determination of fission product retention characteristics. Major emphasis was placed on the xenon and barium release measurements. (auth)

42230 (DP-Report-300) THE PHYSICAL AND MECHANICAL PROPERTIES OF DRAGON-PECHINEY G5 GRAPHITE. Project DRAGON. Kamoun, G.; Gateau, M. (Sud-Aviation S. A., Paris (France)). Nov 1964. 47p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

Experimental methods for measuring some of the more important physical and mechanical properties of graphite in some cases at temperatures in excess of 2000°C, are briefly described. Results of measurements made on a fine-grained graphite designated Dragon–Péchiney G5 are reported, this graphite having been developed as a fuel element material for the Dragon Reactor Experiment. (auth)

42231 (DP-Report-411) THE YOUNG'S MODULUS OF ARTIFICIAL CARBONS AND GRAPHITES (A DISCUSSION OF TEMPERATURE DEPENDENCE). Project DRAGON. Mason, I. B.; Knibbs, R. H. (Atomic Energy Research Establishment, Harwell (England)). Feb 1966. 31p. (AERE-R-5140). Dep. CFSTI.

Earlier reported measurements of the Young's modulus of carbon and graphite artefacts were reinterpreted in the light of a theorem due to Leibfried according to which the thermal oscillation of dislocations enable the latter to break away from pinning points. This accounts fairly satisfactorily for the observed fall in modulus as temperature rises, at temperatures below about 300°C. The rise in modulus above about 300°C is still attributed to a filling of thermal voids, and it is demonstrated that both the Young's modulus and the thermal expansion coefficient are very sensitive to small changes in that part of the voidage which is temperature dependent. Because the expansion coefficient also depends on a part of the voidage that is independent of temperature, there can be no general correlation between the temperature dependence of Young's modulus and expansion coefficient, as was previously suggested. (auth)

42232 (GA-9641) SUMMARY OF CORE SUPPORT GRAPHITE AND CARBON RESEARCH AND DEVELOPMENT TEST PROGRAMS FOR THE FORT ST. VRAIN REACTOR PLANT. Luci, R. K. (Gulf General Atomic, Inc., San Diego, Calif.). 15 Jun 1970. Contract AT(04-3)-633. 113p. Dep. CFSTI.

The core-support graphite components provide the vertical support and the lateral restraint for the reactor core and reflector in the Fort St. Vrain reactor plant. Under normal operating conditions the core-support graphite blocks will be subjected to the weight load of the core and the differential coolant pressure, which together will be equivalent to a load of about 30,000 lb on each block. The support posts (in compression) transfer the vertical load from the core support block to the floor below. The components operate at temperatures between room temperature and 1470°F maximum in a dry helium gas atmosphere (<10 ppM H_2O) during normal operating modes. To evaluate the reliability of the components and materials, a test program was conducted. It was found that the selected core-support graphite and carbon components as designed are satisfactory and will withstand all anticipated loading conditions. No cracks developed in either the spherical ends of the graphite posts or seats after cycling such an assembly at the design load for the design life of the components. The friction and wear characteristics of the selected graphite and carbon materials are not expected to adversely affect the performance of the core-support components. The physical and mechanical properties of the selected graphite and carbon materials meet the minimum specified requirements. Negligible wear and no dimensional changes occurred on a full-scale graphite block and post assembly as a result of the simulated thermal cycling test, which was performed at operational load conditions in a helium environment. Clearances and tolerances of the core-support blocks as designed are satisfactory to permit displacements and rotational movements due to differential thermal expansion and seismic conditions. (J.R.D.)

42233 (KFK-1125) DETERMINATION OF THE OPERATING THERMAL CONDUCTIVITY OF CERAMIC FUEL AND THE COEFFICIENT OF THERMAL CONDUCTIVITY OF THE FISSION GAS BETWEEN THE FUEL AND TUBE ACCORDING TO THE BALANCED OSCILLATOR METHOD. Daenner, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Jan 1970. 171p. (In German). Dep. CFSTI (U. S. Sales Only).

A balanced oscillator method is described in respect of in pile application for measuring the thermal conductivity of ceramic fuels and the gap conductance. It is based upon a comparison of the experimentally and analytically determined transfer function between sinusoidal oscillations in coolant flow and specimen power at constant coolant temperatures. The analytical solution of the transfer function is deduced from the instationary differential equation for heat conduction, taking into consideration radial variation of heat source, heat capacity of the canning, and time dependence of heat transfer coefficient. The result of out pile experiments using coal as specimens prove the feasibility of such experiments and the completeness of the assumptions set up for the analytical solution. Some hints to the in pile realization of the method are included. (auth)

42234 (LIB/Trans-267) EXPERIMENTAL RESULTS SECTION OF: STUDY OF INITIAL SINTERING MECHANISMS. Bacmann, J. J.; Cizeron, G. Translated by W. Buykx (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from J. Nucl. Mater.; 33: 276-85(Dec 1969). 25p. Dep. CFSTI (U. S. Sales Only).

An abstract of the complete article, prepared from the original, appeared as NSA 24: 12469. The translation is of parts 3 to 6 of the article. (Australia)

42235 (NP-10128) THERMAL CONDUCTIVITY MEASUREMENT OF DRAGON TYPE GRAPHITE. A SURVEY OF THE METHODS BEING USED. Project DRAGON. Pass, H. (Atomic Energy Establishment, Winfrith (England)). Mar 1961. 20p. (DP-Report-22). Dep. CFSTI.

The methods being used at present for the measurement of the thermal conductivity of Dragon-type graphite are described. The advantages of each are discussed and recommendations are made. (auth)

42236 (ORNL-TM-3066) THERMAL CONDUCTIVITIES OF Tm_2O_3, Yb_2O_3, AND A Tm_2O_3–Yb_2O_3 MIXTURE. Ketchen, E. E. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 14p. Dep. CFSTI.

The thermal conductivities of Tm_2O_3, Yb_2O_3 and a 46 mole % Yb_2O_3–54 mole % Tm_2O_3 mixture have been measured in a thermal comparator over a temperature range of 400 to 900°C. (auth)

42237 STUDY OF THE VAPORIZATION OF MgO- AND ZrO_2-BASED REFRACTORY MATERIALS. Rutman, D. S.; Shchetnikova, I. L.; Ignatova, T. S.; Kelareva, E. I.; Uzberg, L. V.; Semenov, G. A. Tr. Vost. Inst. Ogneuporov; No. 9, 143-61(1969). (In Russian).

A study was made of the vaporization rate of MgO, Mg_2SiO_4, $MgAl_2O_4$, and $MgCr_2O_4$ at different temperatures in vacuum. Mass spectrometry was used to determine the partial pressure and composition of the vapor at different temperatures. It was established that marked vaporization of MgO began at 1560°. Vaporization occurred most intensively at 1720°. Magnesium and oxygen were present in the vapor over the magnesium oxide. Vaporization of $MgAl_2O_4$ occurred much more slowly than for magnesium oxide. The surface of a spinel specimen after vaporization of magnesium oxide was coated with corundum. At 1500°, Cr_2O_3 was vaporized from chrome spinel, but beginning at 1600° vaporization of Cr_2O_3 and MgO occurred simultaneously. The stabilizing additive CaO was distilled off from zirconium dioxide at 1870 to 2200°, which led to destabilization of ZrO_2. When zirconium dioxide was stabilized with yttrium oxide, vaporization began only at 2200° in the form of the ZrO_2, ZrO, and YO ions. (JPRS)

42238 NEW FORMS OF CARBON. Vohler, Otto; Reiser, Peter-Ludwig; Martina, Renato; Overhoff, Dieter (SIGRI Elektrographit GmbH, Meitingen, Ger.). Angew. Chem. Int. Ed. Engl.; 9: 414-25(Jun 1970).

A number of novel carbon materials whose unique properties fit them for many uses have recently been developed. Pyrolytic graphites are excellent conductors of heat and electricity parallel to the surface, whereas they are semiconductors perpendicular to the surface. A similar anisotropy is found in graphite foils, which are impermeable, but also very flexible. Glasslike carbon, which is also impermeable, is however, completely isotropic. Carbon foams and felts are extremely light and exhibit very good thermal insulation up to high temperatures. In addition to very high strength, carbon fibers have values of Young's modulus greater than that of any other fibers or wires. Carbon fiber/resin composites are therefore more rigid than any other known mate-

rials; their specific Young's modulus is five times that of steel. (auth)

42239 CHEMISTRY OF THE ELEMENTS NIOBIUM AND TANTALUM. LXXI. THE THERMODYNAMIC STABILITY OF THE SEVEN PHASES EXISTING BETWEEN 2.00 AND 2.50 O/Nb. Schaefer, Harald; Bergner, Dieter; Gruehn, Reginald (Univ., Muenster, Ger.). Z. Anorg. Allg. Chem.; 365: 31-50(Feb 1969). (In German).

The 1300°C isotherm of the system $Nb-O-H_2-H_2O$ was determined within the composition range of O/Nb = 2.00 to 2.50. Equilibrium phases with O/Nb ratios of 2.000 to 2.024, 2.417, 2.453, 2.464 to 2.467, 2.472 to 2.478, 2.483, and 2.489 to 2.500. From these measurements the free enthalpies of formation of the NbO_x phases were derived. For information of NbO_x from its two neighboring phases — ΔG^0 is only a few cal/mol NbO_x. Metastable NbO_x phases are also reported. (auth)

42240 ELECTRON MICROSCOPIC INVESTIGATION OF THE DECOMPOSITION OF V_2O_5. Tilley, R. J. D.; Hyde, B. G. (Univ. of Western Australia, Nedlands). J. Phys. Chem. Solids; 31: 1613-19(Jul 1970).

The decomposition of vanadium pentoxide at temperatures up to 400°C in vacuum was investigated using transmission electron microscopy. A number of new phases were found, two of which may be ordered super-lattices of anion vacancies in vanadium pentoxide. No evidence of crystallographic shear was observed. (auth) (UK)

42241 SOME PROPERTIES OF UO_2–SiO_2 MELTS. Lungu, S.; Beleuta, I. L. (Inst. of Atomic Physics, Bucharest). J. Nucl. Mater.; 35: 35-40(Apr 1970).

The vitroceramics of the UO_2-SiO_2 system could possibly be used as nuclear fuels in power reactors for several outlined reasons. Thus, some investigations were carried out on the melts of the UO_2-SiO_2 system in the composition range 60 to 75% mole UO_2. The liquidus curve was in agreement with previous data at the lower limit. The fluidity of the melt was determined from the length of the pins obtained by injecting the melt into fusible tubes. A linear relation between the pin length and the entrance Reynold's number is shown. The hyperstoichiometry of the melts was determined under different melting conditions, and these data were plotted as a function of ΔG_{O_2} as calculated for the gas at the melt surface. (auth)

42242 SPECIFIC GRAVITY OF $NaF-ZrF_4-ZrO_2$ MIXTURES. Fontana, A.; Winand, R. (Univ. Libre, Brussels). J. Nucl. Mater.; 35: 82-6(Apr 1970). (In French).

The specific gravity of various $NaF-ZrF_4-ZrO_2$ mixtures was determined between 1000 and 1100°C by Archimedes' method using a platinum–rhodium alloy sinker. The mean molecular volume of $NaF-ZrF_4$ mixtures free of ZrO_2 varied linearly with the mole fraction of ZrF_4 from 0 to 20 mole % at 1050°C. (auth)

42243 STUDY OF THE WETTABILITY OF GRAPHITE BY DIFFERENT MOLTEN $NaF-ZrF_4-ZrO_2$ MIXTURES IN THE PRESENCE OF VARIOUS GASEOUS ATMOSPHERES. Fontana, A.; Winand, R. (Univ. Libre, Brussels). J. Nucl. Mater.; 35: 87-93(Apr 1970). (In French).

The wettability of graphite by molten $NaF-ZrF_4-ZrO_2$ mixtures was studied by observing the contact angle of drops of the molten salt under a hot-stage microscope in the presence of different gases. The wettability of graphite by these mixtures become less as the ZrF_4 content was increased and the ZrO_2 content reduced. The wettability of graphite by zirconia-free mixtures increased when an argon atmosphere was replaced by CO_2, while for mixtures containing ZrO_2 the change of atmosphere had no effect. CF_4 and CO did not appear to have any significant influence on the wettability of graphite by the mixtures examined. Polished graphite surfaces were much less well wetted by $NaF-ZrF_4-ZrO_2$ mixtures than machined graphite surfaces. (auth)

42244 OXYGEN CHEMICAL DIFFUSION COEFFICIENT OF URANIUM DIOXIDE. Lay, K. W. (General Electric Research and Development Center, Schenectady, N.Y.). J. Amer. Ceram. Soc.; 53: 369-73(Jul 1970).

The diffusion of oxygen in UO_{2+x} was measured at 600 to 1100°C. Samples with initial O/U values 2.08 and 2.04 were reduced in hydrogen; reduction was monitored continuously by electrical conductivity measurements. The relation between total conductivity and average O/U ratio was derived, and the diffusion coefficients were obtained. The validity of the electric conductivity vs O/U relation was checked by measuring weight loss during reduction. Diffusion-controlled kinetics were confirmed by oxygen gradient measurements. The oxygen chemical diffusion coefficient is given by $D = 0.5 \exp -(28{,}500/RT)$. This equation agrees with previously determined values of the oxygen chemical diffusion coefficient of UO_{2+x}. (auth)

42245 CREEP IN YTTRIA- AND SCANDIA-STABILIZED ZIRCONIA. Evans, P. E. (Univ. of Melbourne). J. Amer. Ceram. Soc.; 53: 365-9(Jul 1970).

Compression creep measurements at constant load on ZrO_2-6 mol% Sc_2O_3 (grain size ≈1 μm), ZrO_2-6 mol% Y_2O_3 (grain size ≈ 17 μm), and heat-treated ZrO_2-6 mol% Sc_2O_3 (grain size ≈2 μm) yield activation energies of 89, 86, and 74 kcal/mol, respectively. The creep rates are linearly proportional to the inverse square of the grain size of the material. A stress exponent, n, of 1.5 was found for the scandia-doped zirconia and two regimes, with n = 1 and 6, were found for the yttria-doped zirconia. These data, supported by metallographic evidence, are interpreted as showing that n = 1 is associated with cation diffusion control of creep, n = 6 with local propagation of intercrystalline cracks, and n = 1.5 with a transition region. (auth)

42246 BACON ANISOTROPY FACTOR MEASUREMENTS ON PyC BY X-RAY DIFFRACTOMETRY. Tassone, G. (EURATOM, Brussels). Carbon: 8: 387-8(Jun 1970).

A description is given of a short procedure for determining Bacon Anisotropy Factor measurements on pyrocarbon coatings prepared by deposition on graphite and subsequent removal of the substrate. A curve is presented which can be used for quick determination of B.A.F.'s up to 2.5, the range normally encountered for coated nuclear fuel particles. (UK)

42247 SURFACE AREA AND PORE STRUCTURE OF THORIUM DIOXIDE. Fahim, R. B.; Gabr, R. M.; Mikhail, R. Sh. (Univ. of Assiut, Egypt). J. Appl. Chem. (London); 20: 216-21 (Jul 1970).

Water vapor isotherms at 35°C were measured on two samples of thorium dioxide, one crystalline and the other an amorphous gel. Specific surface areas and pore size distributions were estimated and compared with those obtained from nitrogen adsorption at −196°C. The effect of thermal treatment on both samples was also investigated at 35 to 500°C. It was shown that the adsorption of water vapor on thoria gel is purely physical in nature, and that the gel surface is characterized by the existence of pores of very particular sizes, namely of hydraulic radii 4–6 Å. On the other hand, water seems to interact chemically with the surface of the crystalline sample. In this case the specific surface area could not be evaluated from the adsorption branch of the isotherm, but was successfully evaluated through the application of the "corrected modelless" method to the desorption branch of the water isotherms. This gave the surface area of the total pore system, which was found to be in good agreement with the B.E.T.–nitrogen area. (auth) (UK)

42248 SURFACE AREA AND PORE STRUCTURE OF CERIC OXIDE. Mikhail, R. Sh.; Gabr, R. M.; Fahim, R. B. (Univ. of Assiut, Egypt). J. Appl. Chem. (London); 20: 222-5(Jul 1970).

Adsorption-desorption isotherms of nitrogen at −196°C, and of methanol and cyclohexane vapors at 35°C, were determined on a sample of microcrystalline hydrated ceria and its products of dehydration formed in air at temperatures up to 1000°. The nitrogen adsorption isotherms were analyzed by the de Boer t-method. In one particular sample, the V_a-t plot gave a straight line passing through the origin, which continued until near the saturation pressure. This sample is known to be porous, and its pore size distribution curve gave a most probable hydraulic radius of 35 Å. In analyzing the pore structure, the corrected modelless method was used, and there is an indication that the pores are most likely to be cylindrical in shape. Sintering seems to take place through material transport from wider pores to fill narrower ones, where the total number of pores is reduced. Adsorption of larger molecules than nitrogen, namely methanol and cyclohexane, gave surface area values which are slightly lower than those calculated from nitrogen adsorption. It seems that slight persorption effects can take place in minor fractions of micropores present. However, the remainder of pores present in all samples investigated are accessible to the three adsorbate molecules. (auth) (UK)

42249 PHYSICOCHEMICAL CHARACTERISTICS OF THE INTERACTION OF MoO_3 AND WO_3 WITH GRAPHITE. Elyutin, V. P.; Pavlov, Yu. A.; Sheboldaev, S. B.; Polyakov, V. P.; Meshcheryakov, G. Ya. (Moscow Inst. of Steel and Alloy). Dokl. Akad. Nauk SSSR; 191: 73-5(1 Mar 1970). (In Russian).

Understanding of the reaction mechanism involved in the reduction of refractory oxides requires determination of the solid reaction product on the surface of the reducing agent, especially when the reacting materials are spatially separated. Specimens of MoO_3 and WO_3, which sublime practically without dissociation, were heated to various temperatures in vacuum in the presence of graphite. After the heating, a deposit of the oxide was noted on the surface of the graphite whenever the temperature was higher than the temperature required for the initiation of the interaction between the oxide and carbon (420°C for MoO_3 and 750°C for WO_3);

no such deposit was observed below these temperatures, i.e., no Mo or W could be found by spectral analysis on the surface of the graphite or in its crystal lattice. At 440°C and 540°C, the deposited MoO_3 vapors were reduced to Mo_2O_5; at 640°C the large amount of MoO_3 deposited slows down the reaction, resulting in the formation of a Mo_4O_{11} layer; further temperature increase resulted in a complete reduction of Mo_4O_{11} to Mo_2O_5. At 1050°C the interaction of these oxides with graphite yielded the carbide Mo_2C. The interaction of WO_3 is also accompanied by the formation of a nonhomogeneous oxide layer; in the zones complete reduction to W was obserbed. Beyond 750°C, the effect of CO must be taken into account. (TTT)

42250 SOLIDUS AND LIQUIDUS TEMPERATURES IN THE UO_2–ThO_2 SYSTEM. Latta, R. E.; Duderstadt, E. C.; Fryxell, R. E. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. J. Nucl. Mater.; 35: 347-9(Jun 1970).

Highly refined thermal arrest apparatus was used to determine the solidus and liquidus temperatures for the UO_2-ThO_2 system in the range 0 to 17 mole % ThO_2, using specimens sealed in tungsten capsules. Special attention was given to stoichiometry control. A minimum occurred in the solidus and liquidus temperatures for hydrogen pre-fired specimens at about 5% ThO_2. (G.M.C.)

42251 MELTING POINT AND PHASE TRANSFORMATION OF BERYLLIUM OXIDE. Latta, R. E.; Duderstadt, E. C.; Fryxell, R. E. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. J. Nucl. Mater.; 35: 350-1(Jun 1970).

A thermal arrest method was used to determine the melting point of beryllium oxide. In addition, the α-β phase transformation was observed at 2095°C (heating) and 2058°C (cooling) during a single cycle. (G.M.C.)

42252 MELTING POINT OF PURE ZIRCONIA. Latta, R. E.; Duderstadt, E. C.; Fryxell, R. E. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. J. Nucl. Mater.; 35: 345-6 (Jun 1970).

The melting point of zirconium dioxide was determined to be 2680 ± 15°C by the thermal arrest method. The upper thermal arrest was taken as indicative of the melting point of stoichiometric zirconium dioxide. (G.M.C.)

42253 INTERACTION BETWEEN STRESS AND POROSITY IN ZIRCONIA CERAMICS. King, A. G. (Diamond Shamrock Chemical Co., Solon, Ohio). J. Amer. Ceram. Soc.; 53: 424-5 (Jul 1970).

Stress concentrations observed in CaO- and in MgO-stabilized ZrO_2 are shown to be associated with slip structures and porosity in these materials. Slip band stress relief in the ceramic increases its strength above that expected in specimens in which the stress is retained. This helps to explain the steep rise in the strength-porosity relation at low levels of porosity. (J.R.D.)

Structure and Phase Studies

Refer also to abstracts 41276, 42124, 42817, and 42824.

42254 (DP-Report-132) PHASE EQUILIBRIUM AND THERMODYNAMIC STUDIES OF CARBIDE SYSTEMS RELATED TO HIGH TEMPERATURE REACTORS. Project DRAGON. Benesovsky, F.; Rudy, E. (Metallwerk Plansee, Reutte/Tyrol (Austria)). Jan 1963. 24p. (CONF-630103-3). Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng. From Fuel Element Symposium, Bournemouth, Eng.

Thermodynamic properties and phase studies are reported for the systems U–C, Th–C, and U–Th–C. (J.R.D.)

42255 (DP-Report-322) BASIC STUDIES ON THE STRUCTURE OF PYROLYTIC CARBON. Project DRAGON. Chinaglia, B.; Cocito, G.; Domenici, M.; Pieragostini, F.; Walther, H. (Atomic Energy Establishment, Winfrith (England)). Feb 1965. 64p. Dep. CFSTI.

The structural characteristics of pyrolytic carbon (PC) are described and the properties important for its application as fuel particle coating are studied. The physical properties of PC have been collected and plotted versus the deposition temperature; their general variations with structure are reviewed. The PC coatings of Dragon fuel particles have been examined and the following structural parameters measured versus the deposition temperature (ranging from 1450 to 1900°C): c-spacing and crystallite dimensions by neutron diffraction, porosity by electron microscopy and minimum pore dimensions by small angle scattering of x-rays. Such measurements have been compared with the apparent density and some hypotheses are discussed in order to explain the density minimum at 1500°C. (auth)

42256 (ORNL-tr-2363) TERNARY OXIDES OF Np(IV) AND Am(III) WITH Mo OR W: NpM_2O_8, $Am_2M_3O_{12}$ (M = Mo, W). Freundlich, William; Pages, Monique. Translated by Martha W. Gerrard (Oak Ridge National Lab., Tenn.), from Comp. Rend., Ser. C; 269: 392-4(1969). 3p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 51141.

42257 (UCRL-19630) FIELD ION MICROSCOPY OF TANTALUM–CARBON ALLOYS. Rao, P. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1970. Contract W-7405-eng-48. 5p. (CONF-701003-2). Dep. CFSTI.

From 28th Meeting on Electron Microscopy Society of America, Houston, Tex.

Transmission electron microscopy was used to prove the existence of interstitial order in the C–Ta system. The structure of this order is suggested as $Ta_{64}C$. Field ion micrographs are included along with computer generated field ion images of $Ta_{64}C$. (J.R.D.)

42258 (WAPD-Trans-131) DISLOCATIONS IN CUBIC URANIUM OXIDES. Blank, H.; Ronchi, C. Translated for Bettis Atomic Power Lab., Pittsburgh, Pa., from J. Nucl. Mater.; 31: 1-12(1969). 22p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 22687.

42259 INVESTIGATION OF THE SYSTEM La_2O_3–Yb_2O_3. Mueller-Buschbaum, Hk.; Teske, Chr. (Univ., Giessen, Ger.). Z. Anorg. Allg. Chem.; 369: 249-54(Oct 1969). (In German).

A systematic study of the system La_2O_3–Yb_2O_3 at temperatures of 1650°C as well as above 2000°C shows besides the two well-known mixed crystals (hexagonal A- and cubic C-Form) the existence of a relatively wide perovskite phase in the range La_2O_3: Yb_2O_3 of 45 : 55 to 62 : 38 mole %. By aid of the "tolerance factor" (by Goldschmidt) it is possible to predict unknown perovskites of this type. (auth)

42260 ORIGIN OF CARBIDE INCLUSIONS IN MOLYBDENUM AND ITS CARBON ALLOYS. Ageev, N. V.; Ignatov, D. V.; Kantor, M. M.; Naletov, A. M. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR; 191: 89-91(1 Mar 1970). (In Russian).

Cast molybdenum always contains primary and secondary inclusions of the carbide Mo_2C, resulting from the original eutectic and formed by the decomposition of the solid solution, respectively. These carbide inclusions and the nature of the distribution of these locations in Mo–C alloys was studied by diffraction electron microscopy, examining the effect of the solidification of the melt and its carbon content. The test ingots were prepared in a fast-cooling arc furnace and in an electron beam furnace in which the charge was cooled more slowly. Two different types of inclusions were identified on the basis of their origin: the arc-furnace ingots which contained less carbon then indicated by maximum solubility, exhibited only secondary carbides because the solid solution was supersaturated with carbon. In the solidified electron-beam melts, a certain amount of eutectic inclusions was found because the solid solution was supersaturated to a lesser extent. The dislocation lines in the melts with eutectic inclusions were always straight, showing very few bends. In these cases the decomposition of the solid solution had a definite heterogeneous character and the dislocations affected strongly the decomposition process. Appearance of eutectic inclusions seemed to lead to a decrease of the supersaturation of the solid solution. (TTT)

42261 ENTHALPY OF ACTIVATION OF CARBON SELF-DIFFUSION INTO CUBIC CARBIDES. Oshcherin, B. N. (Leningrad Polytechnical Inst.). Fiz. Metal. Metalloved.; 29: 300-4(Feb 19, 1970). (In Russian).

The enthalpy of diffusion activation is a force acting against the forces responsible for the strength of the lattice. The vacancy diffusion mechanism was studied as related to enthalpy of activation of self-diffusion in crystals with NaCl structure and as related to enthalpy of activation of carbon diffusion in the cubic carbides TiC, ZrC, HfC, VC, NbC, TaC, and UC. (R.V.J.)

42262 APPROXIMATE THEORY OF THE HEXAGONAL AXIS EXPANSION COEFFICIENT OF IMPERFECT GRAPHITE CRYSTALS. Kelly, B. T. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). J. Nucl. Mater.; 35: 50-4(Apr 1970).

An approximate theory is given for the hexagonal axis expansion coefficient of a graphite crystal. This theory allows a comparison of the anharmonicity and compliance due to interlayer forces in imperfect crystals with those of a perfect crystal. The theory shows that marked variations in α_c with crystal perfection are to be expected, in agreement with recent experimental studies. (auth)

42263 KNOWLEDGE OF THE CRYSTAL STRUCTURE OF $LaYbO_3$. Mueller-Buschbaum, Hk.; Teske, Chr. (Univ., Giessen, Ger.). Z. Anorg. Allg. Chem.; 369: 255-64(Oct 1969). (In German).

Single crystals of $LaYbO_3$ were prepared at temperatures above 2200°C. The crystal structure of the orthorhombic distorted perovskite phase (a = 6.01, b = 5.81, c = 8.39 Å, space group C^9_{2v}–$Pna2_1$) was elucidated. $LaYbO_3$ has resemblance to $GdFeO_3$ and $CdTiO_3$, but the identity of space group and atomic arrangement (except the position of one O^{2-}) with the $CdTiO_3$ type is accidental. $LaYbO_3$ represents a hitherto unknown variant of the $GdFeO_3$ type. (auth)

42264 ELECTROSTATIC CHARGES ON DISLOCATIONS IN URANIUM DIOXIDE. Sawbridge, P. T.; Sykes, E. C. (Berkeley Nuclear Labs., Eng.). J. Nucl. Mater.; 35: 122-5(Apr 1970).

It is shown that the bonding in stoichiometric UO_2 is principally ionic, whereas in nonstoichiometric UO_{2+x} the bonding becomes increasingly covalent with increasing values of x. The possibility that dislocations in the stoichiometric material may be charged is discussed. Bond counting around an a/2 ⟨110⟩ screw dislocation demonstrated that screws in UO_2 are always uncharged. In crystals with fluorite structure, it appeared that screw dislocations and edge dislocations on {011} planes are uncharged whereas edge dislocations on {001} planes may be charged. It was concluded that in UO_2, impurity ions or the large intrinsic contribution made to the defect concentration by Frenkel defects on the oxygen sublattice may cause edge dislocations on (001) planes to be pinned. Such pinning would significantly affect dislocation mobility and multiplication and it is suggested that this may significantly affect the deformation characteristics of UO_2 crystals. (M.C.G.)

42265 REDUCTION OF THE COMPACT U_3O_8 BY HYDROGEN. Dymkov, Yu. M.; Nazarenko, N. G.; Dymkova, G. A.; Gorynov, E. F. At. Energ. (USSR); 28: 426-8(1970). (In Russian).

Compacts made of powdered U_3O_8 by hand pressing and calcination at 1000°C for 2 hours in air were used to study the phase changes taking place during the reduction of synthetic uranium oxides with hydrogen. All specimens were soaked at 500°C for 4 hours in hydrogen, then one specimen was removed and slowly cooled for microscopic study while the others were further calcined at somewhat lower temperature. The final product obtained was uranium dioxide. The study revealed that the starting material consisted of a dense compact of slightly elongated grains. Near the cracks long, acicular, nitric acid resistant U_3O_{8-y} crystals were found. Upon reduction in the hydrogen stream, the number of these U_3O_{8-y} crystals increased greatly. The crystals had the same crystal parameters as $UO_{2.50}$ and $UO_{2.60}$ but differed slightly from the U_3O_{13-cx} oxide. From the $UO_{2.59}$ composition on, the UO_{2+x} to U_3O_{8-y} pseudo-morphic cubic crystals appeared. Upon increasing the temperature and extending the period of reduction, the parameter a_0 of the cubic phase of UO_{2+x} changed from 5.4662 to 5.4698 Å. This conversion into lower oxide was preceded by the endotaxial formation of the seeds and growth of the crystal of the new U_3O_{8-y} ($UO_{2.6}$) phase. This intermediate phase was formed simultaneously with the transformation of the earlier intermediate phase into UO_{2+x}. When the whole compact was converted into the cubic UO_{2+x} phase, it was found to crumble; the fragments consisted of a fine-crystalline aggregate corresponding to the texture of the original U_3O_8. (TTT)

42266 SOLID-STATE REACTIONS BETWEEN SrO OR BaO AND SINGLE-CRYSTAL Al_2O_3. Iseki, Takayoshi; Yamaguchi, Kazuo; Tagai, Hideo (Tokyo Inst. of Tech.). J. Amer. Ceram. Soc.; 53: 425(Jul 1970).

Results of experiments at high temperatures showed that in the $SrO-Al_2O_3$ system, $3SrO \cdot Al_2O_3$, $SrO \cdot Al_2O_3$, and $SrO \cdot 6Al_2O_3$ were the products. In the $BaO-Al_2O_3$ system, only $3BaO \cdot Al_2O_3$ was found. It is thought that the process involves a unidirectional transfer of the alkaline earth oxide. (J.R.D.)

42267 STABILIZATION OF ZIRCONIA BY ERBIA. Stewart, R. K.; Hunter, O. Jr. (Ames Lab., Iowa). J. Amer. Ceram. Soc.; 53: 421-2(Jul 1970).

Experiments are described in which high-purity powders were mixed and pressed at 50,000 psi and fired at 2000°C. Results of thermal expansion measurements are presented along with data on tetragonal to monoclinic transformations and on lattice parameters. Solid solution is indicated by the increase in lattice parameter with increasing Er_2O_3 content. (J.R.D.)

42268 CRYSTAL STRUCTURE OF AMERICIUM SESQUICARBIDE. Mitchell, A. W.; Lam, D. J. (Argonne National Lab., Ill.). J. Nucl. Mater.; 36: 110-12(Jul 1970).

The crystal structure and lattice parameter of Am_2C_3 are reported. X-ray diffraction results for heat-treated Am_2C_3 and annealed stoichiometric Np_2C_3 are tabulated. Although the lattice parameter for Np_2C_3 was previously published the d-spacings were not (to the authors' knowledge). (G.M.C.)

42269 THE U_3Si–C SECTION OF THE U–C–Si DIAGRAM ON THE SIDE OF THE U_3Si PHASE UP TO 950°C. Guinet, Philippe; Vaugoyeau, Henri; Jolivet, Jean (Centre d'Etudes Nucleaires, Grenoble, France). J. Nucl. Mater.; 36: 94-8(Jul 1970). (In French).

Several methods employed to obtain the phase diagram U_3Si–C on the side of U_3Si and up to 950°C are described. The maximum amount of carbon dissolved in U_3Si was 1500 ppM at 810°C. The multiphase fields contained an amount of about 2500 ppM of carbon. An isothermal reaction occurred at 810°C. (auth)

42270 STUDIES ON THE UO_2–CaO SYSTEM. Montorsi Appendino, Margherita. Atti Accad. Sci. Torino, I. Cl. Sci. Fis., Mat. Natur.; 104: 449-57(May-Jun 1970). (In Italian).

Solid state equilibria in the calcium oxide–uranium dioxide system were investigated up to 1700°C. To this temperature calcium oxide takes no detectable amount of UO_2 into solid solution. At 1100°C also the CaO shows no solubility into UO_2. At 1400°C The lime begins to dissolve (2 to 3 mole %) and at 1700°C the saturated solid solution contains 25 mole % of CaO. The lattice constant of UO_2 decreases linearly with the amount of lime in solid solution (at 1700°C: a_0 = 5.425 Å). In opposition with the conclusions of some previous investigations, no binary compound was found in the system $CaO-UO_2$. A new compound corresponding to the formula $Ca_2UO_{4.5}$ was obtained instead; to this phase a deformed perovskitic structure was ascribed with orthorhombic symmetry and reticular constants a_0 = 5.76, b_0 = 5.97 and c_0 = 8.28 Å. (auth)

42271 DIAGRAM OF STATE OF THE SYSTEM La_2O_3–WO_3. Ivanova, M. M.; Balagina, G. M.; Rode, E. Ys. (Inst. of General and Inorganic Chemistry, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 914-19(May 1970). (In Russian).

The diagram of state of the $La_2O_3-WO_3$ system was studied and the liquid curve and the character of melting of the phases formed were determined. The formation of five compounds was established with $La_2O_3 : WO_3$ ratios of 1 : 3, 1 : 2, 1 : 1, 3 : 2, and 3 : 1. The 1 : 3 lanthanum tungstate exists in two modifications, alpha and beta, with reversible phase transition at 1025°C, melts incongruently at 1090°C, and forms a eutectic with WO_3. The 1 : 2 tungstate exists in two modifications, alpha and beta, with reversible phase transition at 1070°C. The 1 : 1 and 3 : 2 compositions melt incongruently at 1700 and 1900°C; the latter undergoes reversible phase transformations at 630 and 930°C. The 1 : 1, 3 : 2, and 3 : 1 compositions form solid solutions at 47 to 50, 54 to 60, and 70 to 75 mol % La_2O_3. (tr-auth)

42272 SOLID-PHASE REACTIONS IN THE SYSTEMS Ho_2O_3–Fe_2O_3 AND Pr_2O_3–Fe_2O_3. Kniga, M. V.; Vasil'eva, L. I.; Skomorokhova, A. I. (Belorussian State Univ., Minsk). Zh. Neorg. Khim.; 15: 1394-7(May 1970). (In Russian).

It was found that at an oxide ratio of 1 : 1, only the perovskites $PrFeO_3$ and $HoFeO_3$ are formed. The synthesis begins at 800 to 900°C and ends at 1200°C. At an oxide ratio of 3 : 5, the garnet $Ho_3Fe_5O_{12}$ is formed in the Ho_2O_3–Fe_2O_3 system. Formation of the garnet proceeds through the intermediate perovskite compound. (tr-auth)

42273 STUDY OF THE TERNARY SYSTEM UO_2–PuO_2–Pu_2O_3. Sari, C.; Benedict, U.; Blank H. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater.; 35: 267-77(Jun 1970).

Pellets of uranium-plutonium mixed oxides with Pu/(U + Pu) ratios from 0.05 to 0.97 were reduced in a hydrogen atmosphere at temperatures between 1400 and 2000°C. The results of ceramographic and x-ray diffraction analysis were used to construct the partial U-Pu-O phase diagram at room temperature for O/(U + Pu) ≤ 2.00. Mixed oxides containing less than 20% Pu remained single phase fcc until all Pu was reduced to the trivalent state. A large region containing two cubic phases extended from Pu/(U + Pu) ≈ 0.20 up to the binary Pu-O system. These phases were a fcc phase with O/(U + Pu) = 1.985, in equilibrium with another fcc phase in the range 0.2 ≤ Pu/(U + Pu) ≤ 0.5 and with a bcc phase at higher plutonium contents. For Pu/(U + Pu) > 0.5 and low O/M values, a bcc single phase region extended up to Pu/(U + Pu) = 0.95. At Pu/(U + Pu) = 0.97 this phase was represented by a line with O/(U + Pu) ≈ 1.51. A hexagonal phase of the β-PU_2O_3 type was found for Pu/(U + Pu) ≥ 0.97. The samples reduced below the line $UO_{2.0}$-$PuO_{1.5}$ contained a metallic phase. DTA measurements performed at temperatures up to 1500°C and at different O/(U + Pu) ratios showed that the region of two cubic phases had the shape of a tunnel whose top was at 620 to 640°C in the binary Pu-O system and decreased progressively in the direction of increasing uranium content. (auth)

42274 X-RAY STUDY OF $(U,Pu)_3O_8$. Benedict, U. (Institut fuer Transurane, Karlsruhe, Ger.). J. Nucl. Mater.; 35: 356-61 (Jun 1970).

The oxidation of UO_2-PuO_2 sintered pellets at 600 to 1400°C in air or oxygen led to the formation of orthorhombic α-U_3O_8 with part of the plutonium in its lattice. X-ray diffraction data were used to study the relation between the plutonium content and the lattice parameters of the U_3O_8. (G.M.C.)

42275 CRYSTALLIZATION OF AMORPHOUS ZrO_2 BY THERMAL HEATING AND BY ION BOMBARDMENT. Naguib, H. M.; Kelly, Roger (McMaster Univ., Hamilton, Ont.). J. Nucl. Mater; 35: 293-305(Jun 1970).

Thin films of amorphous ZrO_2 suitable for transmission electron microscopy were prepared by sputtering anodized Zr with 6-keV Kr or O_2 ions and collecting the deposit on unheated KCl. In a first group of experiments, thermal heating of the amorphous films was shown to lead to crystallinity at a temperature dependent on the heating time, for example 520 to 540°C in 5 min. The crystallized films consisted mainly of an apparently cubic form of ZrO_2 together with a certain amount of the monoclinic form, though only the latter persisted to higher temperatures. In further experiments, in which the amorphous films were bombarded with 2 to 35 keV Kr ions, crystallized regions with mean diameters of 250 to 750 Å were found. At currents above about 20 $\mu A/cm^2$ such crystallization was probably in part an impact effect and in part due to beam heating. At lower currents, however, beam heating was insufficient and it was necessary to assume that either displacement spikes, thermal spikes, or radiation-enhanced diffusion plays a role. (auth)

42276 NITROGEN PRESSURE REGION FOR MONOPHASE UC–UN SOLID SOLUTION AND RELATION OF ITS LATTICE PARAMETER AND COMPOSITION. Kai, Hiroshi; Katsura, Masahiro; Sano, Tadao. Technol. Rep. Osaka Univ., 20: 57-66 (Mar 1970).

The relation between the equilibrium nitrogen pressure and the lattice parameter of UC–UN solid solution that coexists with free carbon was obtained at 1800°C using x-ray analysis and ceramographic observation. The validity of Vegard's law for UC–UN solid solution is discussed. Some reasons are suggested for the difference of reported works on Vegard's law. The relation between the lattice parameter and UC/UN ratio was obtained for the solid solution formed in vacuo at 1700°C and 1800°C and in nitrogen containing small amount of oxygen at 1800°C. From the experimental results, it may be concluded: (1) the lattice parameter of UC–UN solid solution shows rather a positive deviation from Vegard's law; (2) the oxygen solution into UC–UN solid solution near the composition of $UC_{0.5}N_{0.5}$ showed little effect on the lattice parameter of the solid solution. (auth)

Radiation Effects

Refer also to abstracts 41172, 43692, 43693, 43695, 43697, 43759, and 43762.

42277 (DP-Report-182) THERMAL CONDUCTIVITIES OF SOME HIGH TEMPERATURE MATERIALS. Project DRAGON. Pass, H.; Stillwell, J. C. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 11p. (CONF-630511-21). Dep. CFSTI.

From Physics Symposium, Bournemouth, Eng.

It is noted that the Dragon reactor is expected to operate at near the maximum permissible temperature. The possibility that the thermal conductivity of the graphite used in the reactor may be associated with operating temperature rise was evaluated. Results were analyzed showing that there appears to be no immediate cause for alarm regarding graphite thermal conductivity or the effects of radiation upon it. However, this conclusion is based on the results of very few experiments and before too much faith is placed in these values many more measurements must be made. (J.R.D.)

42278 (DP-Report-278) THE STEADY STATE DIFFUSION OF FISSION PRODUCT METALS IN PYROCARBON. Project DRAGON. Groos, E. (Atomic Energy Establishment, Winfrith (England)). Jun 1964. 24p. Dep. CFSTI.

An experimental method is suggested and described which is expected to give accurate data about the steady-state diffusion of fission products in pyrocarbon. The limits of applicability of different techniques were calculated and it is concluded that useful results can be obtained if the diffusion coefficients are larger than 10^{-15} to 10^{-16} cm^2/sec. (auth)

42279 (DP-Report-303) IRRADIATION STUDIES ON COATED-PARTICLE FUELS DESTINED FOR THE DRAGON REACTOR. Project DRAGON. Hauser, Gilles (Atomic Energy Establishment, Winfrith (England)). Nov 1964. 31p. (In French). Dep. CFSTI.

Irradiation experiments were made on "coated particle" type fuel. A great number of the particle parameters were varied for the purpose of this study: kernels containing $(Th,U)C_2$ or (Zr,U)C solid solutions of variable compositions, single- or multi-layer pyrocarbon coatings, with or without a layer of silicon carbide. Irradiation conditions (temperature, burnup) were also varied in several facilities either sealed or purged. Results show that it is possible to get very low fission gas releases ($R/3 = 10^{-6}$) at temperatures up to 1600°C. As far as solid fission products are concerned, the best results are observed when using an intermediate layer of silicon carbide within the coating. No influence of the burnup was observed on the fuel behavior. (auth)

42280 (DP-Report-307) PRELIMINARY PROPOSALS FOR POST-IRRADIATION EXAMINATION OF FUEL ELEMENTS FROM DRAGON REACTOR EXPERIMENT. Project DRAGON. Saunders, R. A. (Atomic Energy Establishment, Winfrith (England)). Dec 1964. 37p. Dep. CFSTI.

Plans have been made for post-irradiation examination of fuel elements from the Dragon Reactor. The irradiation program anticipated for the first charge is illustrated. The operations of discharging an element and dismantling it are described and the amount of detailed examination foreseen is tabulated to give estimated work loads. Specifications of required measurements and the collection and treatment of data are considered. (auth)

42281 (DP-Report-308) THE RETENTION OF FISSION PRODUCTS IN DISPERSED FUELS. Project DRAGON. Ashworth, F. P. O. (Atomic Energy Establishment, Winfrith (England)). Jan 1965. 24p. (CONF-650452-2). Dep. CFSTI.

From 2nd Conference on Industrial Carbon and Graphite, London, Eng.

Recent experimental results on the release of fission products from coated particle fuels dispersed in graphite can be interpreted as a combination of recoil and diffusion. Whereas the coating retention for noble gases is good, many metals and halogens escape more readily and migrate to cooler regions of the fuel element where surface absorption and low diffusion coefficients can support a high concentration. Purge arrangements have little control over this release. Future fuel concepts may dispense with purge systems and employ fission product sinks as part of the fuel element structure to complement the retention of the coating. An outline of the design criteria for such fuels is suggested here. The concentration dependence of diffusion and desorption from the surfaces are pointed out and the time dependence of fission product concentration is discussed as a possible limitation to fuel element life. (auth)

42282 (DP-Report-373) ANNEALING AS A POST-IRRADIATION TECHNIQUE FOR THE STUDY OF FISSION PRODUCT RELEASE FROM COATED PARTICLE FUELS. Project DRAGON. Barr, P.; Hauser, G. P.; Vivante, C. (Atomic Energy Establishment, Winfrith (England)). Sep 1965. 34p. Dep. CFSTI.

The results of post-irradiation annealing experiments were compared with in vivo fission gas release measurements on similar fuel to assess the accuracy, relevance, and reliability of the annealing technique for evaluating the fission gas retention properties of coated particle reactor fuel. The temperature dependence of fission gas release was examined, and a short consideration was given to alternative techniques for assessing the behavior of reactor fuel. (auth)

42283 (DP-Report-400) THE IRRADIATION PERFORMANCE OF TRIPLEX COATED (PYROCARBON/SiC/PYROCARBON) FUEL PARTICLES. Project DRAGON. Rose, K. S. B.; Hauser, G. P. (Atomic Energy Establishment, Winfrith (England)). Feb 1966. 25p. (CONF-660318-7). Dep. CFSTI.

From Dragon Contractors' Research and Development Symposium, Harwell, Eng.

Coated particle fuel with a SiC layer was among the most promising experimental fuels tested under a complete range of irradiation conditions, and has been chosen as the fuel for the thorium elements of the first charge of the reactor, and for all the non-experimental elements in the second charge. The behavior of such fuel under irradiation, with respect to metallurgical performances, and in and out-of-pile fission product release is reviewed. The good mechanical behavior of this type of particles and their good retention properties for solid fission products is outlined. It is noted that fission gas release may be attributed to a very small number of particles failed prior to irradiation. (auth)

42284 (IFA-MN-11) NEW RESULTS IN VITROCERAMIC NUCLEAR FUEL RESEARCH. Alecu, I.; Beleuta, I.; Ciocanescu, M.; (and others) (Institutul de Fizica Atomica, Bucharest (Romania)). 1970. 23p. Dep. CFSTI (U. S. Sales Only).

A technique to produce UO_2–SiO_2 vitroceramic fuels by melting,

was developed. This material is suitable as a base of manufacturing a honeycomb-type, coated fuel element. An equilibrium diagram for UO_2-SiO_2 is given. By studying the chemical compatibility of the vitroceramic fuel with a series of gases, it was established that a mixture of 95% CO_2 and 5% CO, compatible with the fuel up to 900°C, may be used as coolant. This led to the choice of an aluminum silicate coating with a high Zr compound content. Radiation effects on the material were studied. The irradiation-induced defects modifying the conductivity are oxygen vacancies. Data are given in graphs on radiation effects on electric conductivity, dimensional changes, and thermal diffusivity. (M.C.G.)

42285 (NP-10335) PAPERS AND SUMMARY OF DISCUSSION OF MEETING ON POST IRRADIATION EXAMINATION AND RADIOCHEMICAL ANALYSIS, MARCH 1961. Project DRAGON. (Atomic Energy Establishment, Winfrith (England)). May 1961. 72p. (DP-Report-31). Dep. CFSTI.

Irradiation experiments and post-irradiation examination, radiochemical analysis of Dragon fuels, Dragon radiochemistry, and fuel developments are discussed. (M.C.G.)

42286 (ORNL-TM-2967) POSTIRRADIATION EXAMINATION OF FUEL ELEMENTS FROM CORE I AND CORE II OF THE ARMY SM-1A STATIONARY MEDIUM POWER REACTOR. Richt, A. E.; Haynes, V. O. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 95p. Dep. CFSTI.

Fuel elements from the first two expended cores for the Army SM-1A Stationary Medium-Power Reactor at Ft. Greely, Alaska were examined to determine the cause of excessive radioactivity in the plant spent-fuel pit facility from Core I fuel elements and to provide basic performance data for UO_2-SS dispersion flat-plate fuel. Examinations were made on all the fuel elements to identify those to be given detailed examination including destructive evaluations. Unusual surface deposits were observed on Core I fuel elements and cladding failures were found that allowed internal corrosive attack of the fuel-dispersion. In fact enough fission products had been leached from such regions that the missing material was evidenced by depressions in the gamma scan activity. Detailed and summary information of the examination is presented. The most likely reason for the release of fission products to the spent-fuel pit water is a pitting-type corrosion that was most likely caused by impurities in the spent-fuel pit water. The elements performed satisfactorily in the reactor and in general accord with behavior that would be predicted from examinations of similar fuel elements that were irradiated in the SM-1A reactor at Ft. Belvoir, Virginia. There appear to be no serious new implications relative to the performance of SM-1A Core III. (auth)

42287 (RD/B/N-990) GROWTH OF FISSION GAS BUBBLES IN IRRADIATED URANIUM DIOXIDE. Cornell, R. M. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Dec 1967. 21p. Dep. CFSTI (U. S. Sales Only).

The growth of fission gas bubbles from supersaturated solution in irradiated uranium dioxide has been studied by electron microscopy under isothermal annealing conditions between 1300 and 1600°C. Measurements of the kinetics of bubble growth have enabled the diffusion coefficients of atomic xenon and krypton in irradiated uranium dioxide to be determined. The diffusion coefficients obtained may be expressed by the equation: $D = (1.6 \pm 0.8)10^{-4} \exp(-88{,}000 \pm 10{,}000/RT)$. The results are believed to be more precise than most of those previously obtained using the Booth Model for gas released from solid samples of irradiated uranium dioxide during a postirradiation anneal. (auth)

42288 EFFECTS OF CONTINUOUS NEUTRON IRRADIATION ON THE STRUCTURE AND PROPERTIES OF MAGNETIC ALLOYS OF THE Fe-Ni-Al-Co ALLOYS TYPE. Grinblat, Yu. N.; Lyashchenko, B. G.; Rogozyanov, A. Ya.; Sakatunov, Yu. S.; Shelkovnikova, G. E. Fiz. Metal. Metalloved.; 29: 252-5(Feb 1970). (In Russian).

Continuous neutron radiation effects were studied on cast cobalt-containing and cobalt-free ceramic alloys of YuNDK (Fe-Ni-Al-Co) type. The specimens were exposed to an integral intensity up to 8.5×10^{20} n/cm² at 630°C. Remote control measurements of magnetic properties and electric resistance, together with optic and electronographic studies of properties and structural changes following irradiation at 200 to 600°C did not reveal any unique changes in electric conductance or magnetic properties. Changes in magnetic properties following irradiation at temperatures above 600°C correspond to the changes induced by ordinary thermal treatment. (R.V.J.)

42289 SWELLING OF A HIGH-TEMPERATURE OXIDE FUEL. Lebedev, I. G.; Kuz'min, V. I.; Piskun, A. S. At. Energ. (USSR); 28: 351-2(Apr 1970). (In Russian).

Samples of UO_2 and PuO_2 were irradiated in a fast neutron reactor, were polished, and examined microscopically in order to determine the volume of insoluble inclusions contributed mainly by the fission products Mo, Tc, Ru, Rh, Pd, Ba, and Sr. The number of inclusions and the volume content did not change after etching in a sulfuric acid-peroxide mixture. The volume of inclusions of a second phase with respect to the oxide fuel after subtracting the gas pores and cracks was found to vary from 0.11 to 0.17% per 1% burnup of the fuel. The calculated value for this increase in volume was found to be about 0.4%. The calculated increase in volume was 0.16% for Mo, Ru, Tc, Rh and Pd in good agreement with the observed value. Gaseous fission products also contribute to swelling of the oxide fuel. (TTT)

42290 GAS SWELLING OF IRRADIATED BERYLLIUM OXIDE. Khudyakov, A. V.; Sudakova, N. V.; Balandin, G. S. At. Energ. (USSR); 28: 157-9(1970). (In Russian).

The stability of beryllium oxide irradiated at high temperatures is affected by the accumulation of fission products, especially helium which may form pores in the material. This question was examined on BeO specimens obtained from the reflector of the SM-2 reactor. The material, prepared by cold pressing and firing at 1800°C, was exposed to an integral fast-neutron flux of 5×10^{20} n/cm² at 70°C. The irradiated specimens were subjected to electron microscopic examination, microscopic picnometry, and porosity determinations. The results revealed that the increased porosity of the irradiated and annealed specimens was due to intergranular porosity. Annealing decreased the open porosity because of the sintering of the subsurface layers; thus, a new pore volume was created without releasing helium to the external surface. As the grain boundary is an excellent source of vacancies, the porosity usually develops at that location of the polycrystalline material. It is therefore recommended to use fine-grain BeO for material intended to be irradiated at high temperatures, thus increasing the total surface of the intergranular boundary. (TTT)

42291 PHYSICOCHEMICAL ASPECTS OF THE APPLICATION OF UO_2 AS A REACTOR FUEL. Klima, J.; Podest, M. (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ.; 16: 82-92(1970). (In Czech).

These physical and chemical properties of uranium dioxide that are most important from the viewpoint of its irradiation behavior are summarized. Structural changes, thermal conductivity, and fission gas release and their mutual relations are emphasized. Some interesting aspects of the behavior of nongaseous fission products are also included. (auth)

42292 EMISSION OF FISSION PRODUCTS FROM URANIUM-PLUTONIUM DIOXIDE DURING IRRADIATION TO HIGH BURN-UP. Findlay, J. R.; Waterman, M. J.; Brooks, R. H.; Taylor, R. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 35: 24-34(Apr 1970).

The emission of fission products from stoichiometric uranium-plutonium dioxide was measured during irradiation between 550 and 1550°C. A burn-up of heavy metal atoms as high as 12.3% was achieved and specimen heat ratings up to 580 watts per gram were employed. Emission of the short-lived fission product gases depended primarily upon temperature and upon the surface condition of the oxide. The emission, in the equilibrium condition, may be described by a diffusion model; the release of ^{85m}Kr and ^{133}Xe is defined between 800 and 1550°C by the equations: $D^{85m}Kr = 2.6 \times 10^{-9} \exp(-1.62/kT)cm^2/sec$, and $D^{133}Xe = 9.2 \times 10^{-9} \exp(-1.89/kT)cm^2/sec$. Within the range of conditions studied, the emission was not significantly affected by the specimen heat-rating. Burn-up was only important because of its indirect effect upon surface area. At sufficiently high burn-ups and temperatures, fiscion products accumulated at grain boundaries and initiated structural changes that increased surface area. At temperatures below 800°C, the release of short-lived gases was controlled principally by a fission recoil-induced knock-out process. Cesium-137 was released at all temperatures; the release occurred with similar characteristics to those found for the short-lived gases. (auth)

42293 EFFECTS OF FISSION FRAGMENT IRRADIATION ON THE THERMAL DIFFUSION OF SiO_2-UO_2 GLASS. Glanz, G.; Radulescu, O. (Institut de Physique Atomique, Bucharest). J. Nucl. Mater.; 35: 102-8(Apr 1970). (In French).

The thermal diffusivity of UO_2-SiO_2 glass-ceramics at different temperatures during reactor irradiation to a low dose was studied. Displacement energies in UO_2, required for the purpose of calculating the number of point defects, were calculated by interpolation from values for other compounds, allowing for the degree of ionic character of the bonds. Effects of irradiation in the crystalline phase (UO_2) and in the glassy phase (SiO_2) were separated by making use of published data for UO_2. The change of the mean free path of phonons in the crystalline phase after irradiation was

interpreted in terms of a point defect model which appears to be adequate. (auth)

42294 FISSION-INDUCED RE-SOLUTION OF SMALL GAS BUBBLES. Gautsch, O. (CCR-EURATOM, Ispra, Italy). J. Nucl. Mater.; 35: 109-14(Apr 1970).

The process of re-solution of small fission gas bubbles in UO_2 upon reirradiation at low temperature was treated by several authors, but is not yet well understood. However, rough numerical estimations of the different gas transport processes through the surface of a bubble indicated that bubbles can shrink owing to the fission-induced sorption of gas in the bubble wall. Since the sorption process tends to saturation because of thermal release and knock-out of the sorbed gas, a complete collapse of the bubble does not occur. The diffusion, knock-out, and the direct recoil of fission-gas atoms from the bulk material into a bubble were found to be negligible as compared to the release and knock-out of the sorbed fission gas atoms from the wall into a bubble. (auth)

42295 IRRADIATION OF FUEL PINS IN INSTRUMENT-EQUIPPED DOUBLE CAPSULES WITH SODIUM AND LEAD-BISMUTH. Haefner, H. E. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik; 12: 248-53(May-Jun 1970). (In German and English).

Following the irradiation of a first series of 55 oxide fuel test pins in lead–bismuth capsules, about 150 pins were irradiated in the Karlsruhe Research Reactor FR 2 in an advanced double capsule type. These were fuel pins of 6 to 7.4 mm external diameter of the cladding tube which, for maximum pin powers of 700 W/cm and cladding tube surface temperatures up to 750°C, attained burnups of 85,000 MWd/t of uranium and U + Pu, respectively. The irradiations are carried out under the Karlsruhe fuel element development program for fast breeder reactors. The type capsules used, as well as with the operating experience gathered, is described. (auth) (In German and English)

42296 ANALYSIS OF FISSION PRODUCT INGOTS FORMED IN URANIUM–PLUTONIUM OXIDE IRRADIATED IN EBR-II. O'Boyle, D. R.; Brown, F. L.; Dwight, A. E. (Argonne National Lab., Ill.). J. Nucl. Mater.; 35: 257-66(Jun 1970).

A metallic ingot removed from the central void of an irradiated UO_2/20 wt % PuO_2 fuel element was examined by means of electron probe microanalysis, gamma spectroscopy, and neutron activation analysis; the fuel element was irradiated at 560 W/cm in EBR-II to a burnup of 5.6×10^{20} fissions/cm^3. The analyzed composition of the ingot was 48.6 wt % ruthenium, 20.0 wt % molybdenum, 16.6 wt % technetium, 12.9 wt % rhodium, and 2.0 wt % palladium; no detectable amounts of uranium, plutonium, carbon, nitrogen, or oxygen were found. The ingot was similar in appearance and chemical composition to the white fission-product inclusions commonly observed in the columnar grains of irradiated oxide fuel and is believed to have been formed by the migration of metallic inclusions up the temperature gradient. The results of the microanalyses of the metallic ingot and the inclusions suggest that some of the molybdenum and palladium migrate toward the cooler region of the fuel during irradiation. The crystal structure of an alloy having the same composition as the metallic ingot but which was prepared from high purity Ru, Mo, Tc, Rh, and Pd was found to be close-packed hexagonal with $a_0 = 2.735$ Å and $c_0 = 4.355$ Å. (auth)

Plastics and Other Materials

Refer also to abstracts 41367 and 41368.

42297 (AEC-tr-7147) POLYMER-CEMENT CONCRETES AND POLYMER-CONCRETES. Solomatov, V. I. Translation of Polimertsementnye Betony i Plastbetony, Izdatel'stvo Literatury po Stroitel'stva, Moscow, 1967. 81p. Dep. CFSTI.

Topics covered include: principles of polymer–cement–concrete technology, properties of polymer–cement concretes, uses of polymer–cement concretes, chemical and technological bases of polymer–concrete manufacture, properties of polymer concretes, polymer concretes in building and structure coverings, adhesive compositions, and polymer concretes in underground structures. (M.C.G.)

42298 (BNL-11263) PRELIMINARY COST ESTIMATE FOR THE RADIATION-INDUCED PLASTIC IMPREGNATION OF CONCRETE. Kukacka, L. E.; Steinberg, M.; Manowitz, B. (Brookhaven National Lab., Upton, N. Y.). [nd]. 18p. Dep. CFSTI.

Results of investigations are reported which are devoted to production of plastic impregnated concrete by gamma-radiation-initiated polymerization of monomers in the aggregate. Emphasis was placed on economic aspects of such processes. It was found that impregnation and irradiation costs vary between 8 and 22¢/ft^2 of total treated surface or between $1.79 and $4.60 per concrete section treated. Monomer and labor charges are the major fraction of the total. Labor makes up 40% of the cost of $\frac{1}{8}$ in. penetration and 16% for full penetration. Relatively low unit ^{60}Co requirements when compared with other costs are found. The cost estimate indicates relatively reasonable costs for improving the properties of concrete pipe. There appears to be sufficient incentive to continue further investigation and development of the radiation-induced plastic impregnation of concrete. In addition, it is suggested that conventional plastic impregnation be evaluated concurrently with the radiation-induced study. (J.R.D.)

42299 (DP-Report-202(Pt.1)) EXPERIMENTAL MEASUREMENTS OF SOME OF THE PROPERTIES OF IRRADIATED AND UNIRRADIATED ELASTOMERS. PART I. THE STUDY OF THE POROSITY TO HELIUM OF SOME UNIRRADIATED ELASTOMER O-RINGS UNDER VARYING TEMPERATURE CONDITIONS. Project DRAGON. Nullens, G. C. (Atomic Energy Establishment, Winfrith (England)). Jul 1963. 38p. Dep. CFSTI.

The permeability of O-rings of different material compositions to helium over their working range of temperatures has probably not been the object of any publication. An experimental program was set up to measure the permeability for as many elastomer materials as possible. This part of the report deals only with unirradiated products, but the intention is to extend the report to O-rings which will have been irradiated at various radiation doses. (auth)

42300 (DP-Report-202(Pt.2)) EXPERIMENTAL MEASUREMENTS OF SOME OF THE PROPERTIES OF IRRADIATED AND UNIRRADIATED ELASTOMERS. PART II. THE MEASUREMENT OF IRRADIATION EFFECTS ON THE MECHANICAL PROPERTIES OF SOME ELASTOMERS. Project DRAGON. Nullens, G. C. (Atomic Energy Establishment, Winfrith (England)). Jul 1963. 34p. Dep. CFSTI.

O-rings of various elastomeric compositions were γ-irradiated by reactor waste at AERE Harwell with different radiation doses. The changes in hardness, tensile strength, and elongation were measured in order to assess, for each material, the maximum radiation dose it could accept and still be usable. The results are not very accurate due to the fact that the test specimen did not have the right geometry but, nevertheless they are still very useful. (auth)

42301 (DP-Report-202(Pt.3)) EXPERIMENTAL MEASUREMENTS OF SOME OF THE PROPERTIES OF IRRADIATED AND UNIRRADIATED ELASTOMERS. PART III. THE MEASUREMENT OF THE EFFECTS OF IRRADIATION ON THE POROSITY TO HELIUM OF SOME ELASTOMER O-RINGS UNDER VARYING TEMPERATURE CONDITIONS. Project DRAGON. Woodley, H. J. (Atomic Energy Establishment, Winfrith (England)). Feb 1965. 32p. Dep. CFSTI.

The Dragon Reactor includes many items which utilize elastomer seals that are subjected to various temperatures and irradiation doses. As far as is known no previous publication describes the permeability to helium of elastomers under these conditions. These effects were measured on a range of commercially available elastomers and the results are recorded here. In general it can be stated that not even the best elastomers can be used in the Reactor at temperatures above 180°C, while the maximum tolerable radiation dose is in the range 10^8 to 10^9 rads. (auth)

42302 (NP-10677) CONCRETE AS A CONSTRUCTIONAL MATERIAL FOR THE DRAGON PROJECT. Project DRAGON. Williams, T. G. (Atomic Energy Establishment, Winfrith (England)). Jul 1961. 10p. (DP-Report-43). Dep. CFSTI.

Details of concrete used for the construction of the Dragon reactor are given from the following aspects: specification, materials, mix design, manufacture, testing routine, and typical test results. (auth)

42303 IMPROVEMENTS IN OR RELATING TO RADIATION AND ACOUSTIC BARRIERS. Prahl, Helmut Ferdinand. British Patent 1,196,681. 1 Jul 1970. Priority date 22 Mar 1967, United States.

A mixture of materials suitable for use as a plastic radiation and acoustic shielding is composed of 1.5 to 24.8 wt % of hardenable epoxy resin, 75 to 95 wt % of powdered radiation attenuator selected from Pb, W, Bi, Ta, Tl, and U, and their compounds and alloys, and 0.2 to 7.5 wt % of a thixotropic agent such as colloidal silica, hydrogenated castor oil, bentonite, kaolinite clay, colloidal cellulose, or colloidal asbestos. The thixotropic agent enables the composition to be applied without sagging on vertical surfaces. (B.L.M.)

42304 LUBRICATION OILS FOR ATOMIC POWER GENERATION. 1. Shinozaki, Sadayuki; Iwanaga, Yoshihiro (Idemitsu

Kosan Co. Ltd., Tokyo). Sekiyu To Sekiyu Kagaku; 14: No. 1, 126-30(Jan 1970). (In Japanese).

Following the development of atomic power generation in Europe and the US, atomic power stations are emerging in Japan. By 1985, 24% to 36% of the power generation in Japan will be by atomic energy. Compared to the case of thermal power stations, the requirements for lubricating oils are peculiar: in addition to the lubricating property and oxidation stability, the radiation damage is very significant. Lubrication oils used in the atomic power station, and the radiation environment, are described for the following power components: turbogenerators; reactor facilities, including coolant pumps, control-rod drive, stop and control valves, fuel-loading machines and auxiliaries, including chemical and volume control systems, cooling systems, and gaseous and liquid waste systems. (Japan)

42305 ROLLING FRICTION OF HIGH-DENSITY POLYETHYLENE IRRADIATED BY γ-RAY. Watanabe, Makoto; Matsubara, Kiyoshi (Government Mechanical Lab., Tokyo). Junkatsu; 15: No. 2, 99-100(Feb 1970). (In Japanese).

In studies on the friction-abrasion of γ-irradiated polyethylene, rolling friction has been measured, and also, using the same sample, its viscoelasticity has been measured by the torsional oscillation method. In the former measurement, the γ-irradiated polyethylene film of 1 mm thickness was placed on the base plate, a $\frac{1}{2}$ in. steel ball was put on the film, and a dry glass plate was placed on the ball. The frictional force applied to the glass plate was measured when the base plate was moved. In the latter measurement, the dynamic rigidity (G) and the loss tangent (tan δ) were obtained with a torsional oscillation testing machine. In contrast to the case of sliding friction, the rolling friction as a whole decreased with radiation dose. The change of tan δ/G value with the dose showed the same tendency as for the rolling friction. It was concluded that the change in rolling friction of polyethylene by γ irradiation is due to the change of rigidity and loss tangent. (Japan)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstract 42895.

Cosmic Ray Exposure Ages

Refer also to abstract 41238.

42306 RARE GAS ANOMALIES AND INTENSE MUON FLUXES IN THE PAST. Takagi, J. (Tokyo Metropolitan Univ.). Nature (London); 227: 362-3(25 Jul 1970).

Several explanations of the excess ^{129}Xe and ^{131}Xe in terrestrial Te ores have been proposed, and the present author pointed out that the observed $^{129}Xe/^{131}Xe$ ratios are well explained by muon interactions on Te isotopes. The intense muon flux necessary for the production of the observed amount of Xe isotopes was considered to have been produced through the resonant scattering on high-energy electron antineutrinos emitted in the explosion of the Galaxy. Analytical data on the isotopic composition of Xe in tellurides appear to be consistent with the explosion mechanism. In the present communication it is pointed out that the anomalies in the rare gases from underground sources can be explained by a muon flux similar to that assumed for the explanation of the xenon anomaly in tellurides. In the case of ^{21}Ne and ^{22}Ne the ratio can be explained by muon interactions, chiefly on Na, in the Earth's crust. The excess of ^{3}He in seawater can also be explained in the same way. The muon fluxes necessary for the observed excess of $^{21,22}Ne$ and ^{3}He are estimated and results are tabulated, together with production rates. The argument is restricted to the rare gas anomalies in underground sources, and a much higher muon flux is necessary to induce appreciable changes in the rare gas isotopic composition in the terrestrial atmosphere. This higher flux may be supplied by violent events in the early history of the solar system. (UK)

42307 MULTIPARAMETER ANALYSIS OF GAMMA RADIATION FROM THE BARWELL, St. SEVERIN, AND TATLITH METEORITES. Cressy, Philip J. Jr. (Goddard Space Flight Center, Greenbelt, Md.). Geochim. Cosmochim. Acta; 34: 771-9(Jul 1970).

Cosmogenic gamma-emitting radionuclides in the Barwell, St. Séverin, and Tatlith stone meteorites were measured, shortly after fall, in a non-destructive gamma–gamma coincidence counting system. Comparison of the St. Séverin results with specific activities reported by other investigators on nearby samples of Stone D confirms the location of the preatmospheric surface. An initial factor-of-two buildup in the concentrations of the low-energy spallation products ^{22}Na, ^{26}Al, and ^{54}Mn is observed at 10 to 20 cm depths. Activity ratios in Barwell, St. Séverin, and Tatlith are compared with 9 published analyses of other freshly fallen stone meteorites. Relying primarily on $^{10}Be/^{26}Al$ activity ratios, the various specimens are arranged in order of increasing depth, samples of Granès, Harleton, and St. Séverin (DII_2) being least shielded and Bruderheim, Tatlith, and St. Séverin Stone A most shielded. In the least-shielded samples the $^{46}Sc/^{54}Mn$ activity ratio is 0.34, some three times larger than expected from artificial bombardment data. All the $^{51}Cr/^{54}Mn$ ratios are higher than predicted, but the ratio of 2.1 in the unshielded Granès sample is highest of all, a factor of three greater than expected. The three least-shielded samples have $^{60}Co/^{54}Mn$ ratios much higher than that of any specimen except the well-shielded St. Séverin A sample. The relative enrichment in ^{51}Cr and ^{46}Sc can be explained by a low-energy solar flux, on the order of 5 nucleons/cm^2/sec between 50 and 200 MeV. The ^{60}Co surface enrichment suggests a history of exposure to solar flares. (auth) (UK)

42308 NOBLE GASES IN CARBONACEOUS CHONDRITES. Mazor, Emanuel (Univ. of Chicago); Heymann, Dieter; Anders, Edward. Geochim. Cosmochim. Acta; 34: 781-824(Jul 1970).

He, Ne, Ar, Kr, and Xe were measured in 73 samples of 32 carbonaceous chondrites and 3 ureilites. All carbonaceous chondrites contain "planetary" primordial gas; many also contain "solar" gas. Types I, II, and III V (= Vigarano subclass) always have sizable contents of He and Ne, with mean $^{4}He/^{20}Ne$ = 340, 220, and 290; $^{20}Ne/^{36}Ar > 0.2$. Types III O (= Ornans subclass), C4, and ureilites have little or no primordial He and Ne; $^{20}Ne/^{36}Ar \leq 0.03$. These trends were probably established during accretion rather than during metamorphism. Primordial He shows a more than threefold variation in $^{3}He/^{4}He$ ratio, from $\sim 1.2 \times 10^{-4}$ to $\sim 4 \times 10^{-4}$. Much smaller variations, from 5.3 to 5.5, were found for $^{36}Ar/^{38}Ar$. Both correlate with the well-known variation in $^{20}Ne/^{22}Ne$. Radiation ages for Types I and II are always less than 15 m. y., while those for Type III extend to 40 m.y. This trend correlates with crushing strength and may imply that the age distribution is governed by the meteorites' lifetime against collisional destruction. K–Ar ages increase in the order I < II < III, presumably reflecting increasing grain size and gas retentivity. Radiogenic ^{129}Xe contents for most meteorites lie between 2 and 10×10^{-10} ccSTP/g, although $^{129}Xe/^{132}Xe$ ratios vary by a factor of 400. Most carbonaceous chondrites also contain a fission component; it is more abundant in low-temperature meteorites or structural components (I's, II's, III V's, matrix) than in those showing evidence of higher temperatures (III O's, C4's, chondrules). Apparently it is derived from a volatile progenitor, perhaps a super-heavy element of Z = 112-119. (auth) (UK)

42309 FOSSIL PARTICLE TRACKS IN EXTRATERRESTRIAL MATERIALS. Walker, R. M. (Washington Univ., St. Louis). Radiat. Eff.; 3: 239-48(Jun 1970).

Track studies in extraterrestrial materials can be used to obtain unique information about a number of problems including cosmic rays, solar flares, nucleosynthesis, planet formation, and dynamic processes such as erosion of bodies in space. This article, written before the reception of the first lunar samples, summarizes prior work done on meteorites and makes projection for track studies in lunar materials. By and large, the actual results on the lunar samples reported in Science 167 (Jan. 1970) follow the projections made here. (auth)

42310 RARE EARTH AND OTHER ELEMENTAL ABUNDANCES IN THE ALLENDE METEORITE. Wakita, H.; Schmitt, R. A. (Oregon State Univ., Corvallis). Nature (London); 227: 478-9(1 Aug 1970).

About 1000 kg of this Type III carbonaceous chondrite was recovered, offering an unparalleled opportunity for study, and a determination of the abundances of 28 elements is reported. Abundances of Al, Ca, V, Mn, Na, Sc, Cr, Fe, and Co were determined by instrumental neutron activation analysis, and rare earth elements plus Y, Rb, Cs, Cd, and In by radiochemical neutron activation analysis. Results are tabulated and discussed. It was concluded that all the abundances confirmed the classification of Allende as a Type III carbonaceous chondrite. (UK)

Stars

42311 (NP-18375) HOT EXTREME POPULATION II STARS. Newell, Edward B. (Australian National Univ., Canberra). 1969. 250p. Dep. CFSTI (U. S. Sales Only).

Thesis.

Atmospheric parameters, effective temperature, and surface gravity were determined for a number of hot, predominantly blue horizontal-branch (B.H.B.) stars, that are members of the globular cluster and galactic halo population. Observation, using narrow-band interference filters, and low-dispersion image-tube spectrographs, indicated that the B.H.B. stars in the globular clusters NGC 6397, ω Centauri, M15, M13, M92, M3, and M4 have similar ranges of surface gravity and effective temperature. Log $(M/L) = -2.0 \pm 0.1$ for these clusters. The similarity of the B.H.B. stars in clusters that exhibit a range of metal abundance can be interpreted as evidence for variations in the B.H.B. helium abundance or mass, or both. A group of stars, believed to be disk horizontal-branch stars, was discovered, resembling those occupying the horizontal branch of galactic cluster M67. (Australia)

42312 WAVELENGTH OVERLAP OF TRANSITIONS FROM DIFFERING STAGES OF IONIZATION. Connerade, J.-P. (European Space Research Inst., Frascati, Italy). Astrophys. J.; 161: 785-8(Aug 1970).

It is suggested that corresponding inner-shell transitions from different stages of ionization of the same element could overlap in energy, although no examples of overlap exist in the literature. A case of overlap is quoted for optical transitions of a similar structure to illustrate this possibility. (auth)

42313 BLUE HORIZONTAL-BRANCH STARS OF M4. Newell, E. B. (Yale Univ., New Haven). Astrophys. J.; 161: 789-92(Aug 1970).

A preliminary study was made of the blue horizontal-branch stars in the metal-rich globular cluster M4. The techniques described by Newell, Rodgers, and Searle were used to derive atmospheric parameters (log g and θ_e) and the reddening for each star. A mean reddening of $\langle E(B-V)\rangle = 0.45$ mag + 0.03 mag is derived. An average mass–luminosity ratio for the stars studied is $\langle M/L\rangle = -2.0 \pm 0.1$. To within the accuracy of the present series of investi-

gations the blue horizontal-branch stars in M4 have atmospheric properties indistinguishable from those of the blue horizontal-branch stars in extremely metal-poor globular clusters. (auth)

42314 EXCITATION OF He II IN WOLF–RAYET ENVELOPES. Castor, John I.; Van Blerkom, David (Univ. of Colorado, Boulder). Contract DA-31-124-ARO-D-139. Astrophys. J.; 161: 485-502 (Aug 1970).

The conditions of excitation which determine the strengths of the many He II emission lines in the spectra of Wolf–Rayet stars were investigated. The observed line intensities from the WN 6 stars HD 192163 and HD 191765 were used to infer the level populations of He II ions in their envelopes. Then, an ab initio calculation of the populations of the first thirty levels of He II was performed in which the equations of statistical equilibrium were solved with all radiative and collisional transitions included. The calculation of line transfer was based on the radial-expansion model of Wolf–Rayet envelopes, for which simplification of the transfer problem was achieved by means of an escape-probability method. The continua were treated in a similar manner, and the level populations were obtained at one representative point in the envelope. For plausible combinations of temperature and density there is good agreement between the computed populations and those inferred from the observed line intensities. It was concluded that the radial-expansion model is a valid description of the region in which He II lines are formed. (auth)

42315 SPECTRA OF STELLAR FLARES. Kunkel, William E. (Univ. of Texas, Austin). Astrophys. J.; 161: 503-18(Aug 1970).

New broad-band photometry and time-resolved low-resolutions spectra of dMe flares are reported. They are interpreted in terms of a two-component model in which the principal and dominant component is a layer of recombining hydrogen with characteristics similar to those found in solar flares. The second component, the formation of which lags somewhat behind that of the first, consists of impulsive heating of the photosphere beneath the flare. It is found that the surface extent of flare outbursts from dMe stars covers only a few percent of the apparent stellar disk despite total energies which on occasion exceed by two orders of magnitude the total output of a solar flare of class 3+. (auth)

42316 FAINT END OF THE MAIN SEQUENCE. Greenstein, Jesse L. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.); Neugebauer, G.; Becklin, E. E. Astrophys. J.; 161: 519-31(Aug 1970).

New infrared observations of the two faintest known, late M dwarfs, Wolf 359 and +4°4048B (=VB 10) provide accurate luminosities and moderately well-determined temperatures (2500° and 2250°K, respectively). The photometric observations are fitted to a blackbody energy distribution on the assumption that line and band blocking affect most of the spectrum below 1 μ; the temperature structure is taken as that of a gray body. The resulting data, together with Johnson's observations for dM4 and dM5 stars, which have been reanalyzed, calibrate the faint end of the main sequence, with results given in a table and a figure. The bolometric corrections are very large and increase steeply to 6 mag, so that the faintest known stars are, in fact, not very faint; Wolf 359 has $L = 13 \times 10^{-4}$ $L_\odot$, and VB 10 has $L = 5 \times 10^{-4}$ $L_\odot$. A statistical discussion of Luyten's faint red stars of large proper motion gives $L = 4 \times 10^{-4}$ $L_\odot$. With a conventional mass–luminosity relation, $\mathfrak{M} \geq 0.09\,\mathfrak{M}_\odot$, for stars of known luminosity. Stars of still lower mass, such as L726–8, are difficult to interpret. (auth)

42317 MOLECULAR ABUNDANCES IN K AND M STARS. Goon, G. (Princeton Univ., N. J.); Auman, Jason R. Astrophys. J.; 161: 533-9(Aug 1970).

The projected densities of the molecular constituents of K and M stars were calculated by using the model atmospheres given by Auman and were compared with observed densities. The low H_2O abundance in M stars is discussed. It is concluded that the low abundance may be due either to changes in the carbon and oxygen abundances or to the fact that the effective temperatures of these stars have been underestimated. The electronic transitions of HCO and NH_2 and the vibration-rotation bands of H_2S may contribute to the opacity in the cooler stars. The photodissociation of NaCl may be a source of opacity in the ultraviolet. There is a possibility that the ν_3 band of CO_2 at 4.25 μ may be observable in the late M stars and that the absorption feature found at 8 μ in the M stars may be partly due to the ν_2 band of H_2S. (auth)

42318 NUMERICAL EXAMPLE OF THE COLLAPSE OF A ROTATING MAGNETIZED STAR. LeBlanc, J. M.; Wilson, J. R. (Univ. of California, Livermore). Astrophys. J.; 161: 541-51 (Aug 1970).

The time history of a star of 7 $M_\odot$ undergoing gravitational collapse due to iron decomposition is calculated numerically. The angular velocity assumes a vortexlike distribution which halts the collapse at a relatively low density, 10^{11} g cm^{-3}. The large shear in the velocity field gives an enhancement of about 100 in the multiplication of magnetic-field energy over the energy multiplication from simple compression. The combined effect of rotation and magnetic field is to produce an axial jet. At a radius of 4×10^6 cm where the jet material leaves the calculational grid, the jet carries a mass of 2.1×10^{31} g and a total energy of 1.6×10^{50} ergs. The energy is principally kinetic, 1.6×10^{50} ergs, but it also has a large magnetic energy equal to 3.5×10^{49} ergs, and only 1.1×10^{49} ergs of internal energy. (auth)

42319 ELECTRICAL AND THERMAL CONDUCTIVITY IN A SUPERDENSE LATTICE. I. HIGH-TEMPERATURE CONDUCTIVITY. Solinger, Alan B. (Goddard Space Flight Center, New York). Astrophys. J.; 161: 553-9(Aug 1970).

The electrical and thermal conductivities are computed analytically for conditions which prevail in white-dwarf cores and the outer layers of neutron stars. The case is considered in which the temperature is well above the Debye characteristic temperature, and the transition probability for electron–phonon collisions is calculated. Because of the peculiar conditions, namely, a Debye length that is much larger than the interatomic spacing, both N- and U-processes can be quite easily included, and a single relaxation time characterizes the interaction. Relativistic effects are taken into account through use of the Dirac wave function for the electron field, and in the relativistic Boltzmann equation. The resulting formula has the exceedingly simple form $\sigma = 1.04 \times 10^{22} T_8^{-1} (\rho_6/\mu_e)^{\frac{5}{3}}$ sec^{-1}, where σ is the electrical conductivity, μ_e is the electron "molecular weight," ρ_6 is the density in units of 10^6 g cm^{-3}, and $T_8 = T/10^8$. The constant is independent of the ion mass, density, and charge. The conductive opacity turns out to be $K_c = 2.81 \times 10^{-3} \mu_e^{\frac{5}{3}} \rho_6^{-\frac{1}{3}} T_8^{\frac{3}{2}}$. (auth)

42320 EFFECT OF GRAVITATIONAL RADIATION ON THE SECULAR STABILITY OF THE MACLAURIN SPHEROID. Chandrasekhar, S. (Univ. of Chicago). Contract Nonr-2121(24). Astrophys. J.; 161: 561-9(Aug 1970).

It is shown that the dissipation of energy by gravitational radiation induces (in the manner of viscosity) a secular instability of the Maclaurin spheroid at the point of bifurcation where the Jacobian sequence branches off. But the mode of oscillation that is made unstable by radiation reaction is not the same one that is made unstable by viscosity. (auth)

42321 EVOLUTION OF THE JACOBI ELLIPSOID BY GRAVITATIONAL RADIATION. Chandrasekhar, S. (Univ. of Chicago). Astrophys. J.; 161: 571-8(Aug 1970).

The quasi-static evolution of the Jacobi ellipsoid by gravitational radiation is determined by integrating the equation that gives the rate of dissipation of the angular momentum with the constraint that the ellipsoid remains Jacobian at all times. It is found that the evolution is in the direction of increasing angular velocity toward a non-radiating state at the point of bifurcation with the Maclaurin sequence. (auth)

42322 RAPIDLY ROTATING STARS. V. THE COUPLING OF THE HENYEY AND THE SELF-CONSISTENT-FIELD METHODS. Jackson, Stephen (Princeton Univ., N. J.). Contract AF 49(638)-1555. Astrophys. J.; 161: 579-85(Aug 1970).

The self-consistent-field method of Ostriker and Mark is extended by the incorporation of the Henyey method to permit the construction of models for rapidly and differentially rotating stars that fully include the details of nuclear-energy generation and radiative transport. (auth)

42323 METAL-POOR STARS. III. ON THE EVOLUTION OF HORIZONTAL-BRANCH STARS. Iben, Icko Jr.; Rood, Robert T. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 161: 587-617(Aug 1970).

The evolution of low-mass stars of composition Y = 0.1, 0.2, 0.3 and log Z = –3, –4 during the phase of core helium burning is described. Several models for Y = 0.3 are evolved until a large carbon–oxygen core develops. By comparing properties of giant-branch and horizontal-branch models with the observations, it is found that $Y \sim 0.29 \pm 0.05$ best describes cluster stars if $Z = 10^{-3}$–10^{-4}. For such compositions, model tracks during core helium burning are all quite short compared with the color width of horizontal branches appearing in nature. It is concluded that there may be a spread in stellar mass along the horizontal branch that is of the order of 0.1 to 0.2 $M_\odot$. It is shown that if the mass distribution is continuous, the horizontal branch will define a solid wedge in the color–magnitude diagram regardless of whether or not an individual track exhibits a blueward hook.

Using current estimates of the initial mass of the helium core when losses due to plasma neutrinos are included, ages for M3, M92, and M15 are estimated to be on the order of 11 to 13 billion years. RR Lyrae luminosities are consistent with those given by the method of statistical parallax and are only slightly larger than those currently suggested by pulsation theory when fitted to the observations. It is inferred that most of an observed rate of period change dP/dt for RR Lyrae stars is "noise." The distinct bias toward positive values of dP/dt in ω Cen and the small value of $\langle dP/dt \rangle$ in M3 can be interpreted as evidence that stars in M3 pass through the instability strip during the major phase of core helium burning and hence have high Z, whereas stars in ω Cen pass through the strip rapidly from blue to red toward the end of core helium burning and hence have low Z. Finally, the secondary or asymptotic giant branch in globular clusters is identified as the residence of stars that are burning helium in a shell outside a carbon–oxygen core. These stars evolve upward and to the red in the H–R diagram. (auth)

42324 EVOLUTION OF LOW-MASS STARS. I. CONTRACTION TO THE MAIN SEQUENCE. Grossman, Allen S. (Iowa State Univ., Ames). Astrophys. J.; 161: 619-32(Aug 1970).

The approach to the main sequence of stars in the mass range 0.06 to 0.2 $M_\odot$ was investigated for the composition X = 0.68, Y = 0.29, and Z = 0.03. The theoretical main sequence in the spectral range M4–M8 was determined for l/H_p ratios of 1 and 2, and its position in the H–R diagram was found to be practically independent of the l/H_p ratio. The agreement between the theoretical and the observational main sequence in the M4–M8 region was examined, and it was found that the star models calculated are consistent with the observations. The age of stars on the main sequence in the M8 region is on the order of 10^9 years. The main-sequence mass limit at the composition given above was estimated to be 0.075 $M_\odot$. The evolution of a 0.1 $M_\odot$ star was studied in detail in order to determine the role played by chemical composition in determining the lower mass limit of the main sequence and the effects of primordial deuterium and lithium burning. At the above composition the 0.1 $M_\odot$ star does reach a stable main-sequence stage for both $l/H_p = 1$ and $l/H_p = 2$. With an $X_D = 0.19 \times 10^{-3}$, the primordial deuterium burning increases the approach time to the main sequence by about 10^6 years. Electron-screening factors which were scaled for the intermediate cases between weak and strong screening were used to calculate the nuclear-reaction rates at 0.1 $M_\odot$. The effects of water-vapor opacity and pressure ionization and dissociation have been included in the star-model calculations. (auth)

42325 MODELS OF MAGNETIC STARS. Trasco, John D. (Columbia Univ., New York). Astrophys. J.; 161: 633-42(Aug 1970).

A first-order approximation for the effect of a magnetic field on the structure of a star is obtained by solving the spherically symmetric problem in which the actual Lorentz force is replaced by its radial component averaged over a spherical shell. The case considered is that of a small-scale, randomly oriented magnetic field for which the mean square of the field strength can be written as some power of the density. The calculations show that magnetic stars will be cooler and less luminous than nonmagnetic stars of the same mass and that the magnitude of the effects are comparable to those of rotation. Observations indicate that among cool stars (later than A0), those with magnetic fields show an excess in m_1 and a deficiency in c_1 compared with nonmagnetic stars with the same β. In both cases, the departure from the normal value shows a correlation with the maximum observed value of the magnetic field. The effects of magnetic fields as calculated here, as well as those which have been published for rotation, are in general too small to account for these anomalies; whereas blanketing corrections are of the same order as the observed deviations. (auth)

42326 STATIC STRUCTURE OF LONG-PERIOD VARIABLE STARS. Keeley, Douglas A. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 161: 643-55(Aug 1970).

Static-model calculations are presented for stars with masses of 1 and 1.3 $M_\odot$ and with solar composition. The equation of state includes a detailed calculation of ionization equilibrium and the dissociation of H_2, OH, CO, and H_2O. The opacity due to H_2O, OH, and CO is included. Preliminary dynamical calculations show fundamental and overtone instability. The fundamental periods range from 180 days to greater than 2000 days; the first-overtone periods are roughly one-third as long. The periods and positions of models in the H–R diagram suggest that many observed stars may be overtone pulsators. (auth)

42327 DYNAMICAL MODELS OF LONG-PERIOD VARIABLE STARS. Keeley, Douglas A. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 161: 657-67(Aug 1970).

It is shown that large-amplitude pulsation can occur in stars which are convective through most of the envelope. The opacity mechanism causes strong driving of the pulsation in the region outside the hydrogen-ionization zone, and the Γ mechanism results in very low dissipation in the hydrogen zone. The phase relation between the bolometric luminosity and the variations in radius is similar to that of Cepheids. A relaxed fundamental pulsator is discussed in detail, and some overtone pulsators and two models close to dynamical instability are described briefly. (auth)

42328 PULSATION CONSTANTS AND DENSITIES FOR DOUBLE-MODE VARIABLES IN THE CEPHEID INSTABILITY STRIP. Fitch, W. S. (Univ. of Arizona, Tucson). Astrophys. J.; 161: 669-78(Aug 1970).

Pulsation constants and period ratios are given for the first six radial pulsation modes of a set of seven polytropes with indices ranging from n = 2.25 to n = 4.00. The polytrope results are combined with published theoretical data from pulsation calculations for stellar models and observational data on thirteen double-mode variables in the Cepheid instability strip to obtain four interpolation formulae relating fundamental periods P_0, pulsation constants Q_0, and period ratios P_1/P_0 and P_2/P_1. The derived relations are used to obtain accurate densities for the thirteen observed variables, which include six dwarf Cepheids or AI Velorum stars, one δ Scuti star, one RR Lyrae star, and five Cepheids. Approximate masses and luminosities are obtained for some of these stars. The probable connection between mass–luminosity ratios and the existence of double-mode variables is discussed. (auth)

42329 METHOD FOR DETERMINING THE INTRINSIC COLORS OF CEPHEIDS FROM THEIR PERIODS AND LIGHT AMPLITUDES. Fernie, J. D. (Univ. of Toronto). Astrophys. J.; 161: 679-84(Aug 1970).

It is shown that the equations $(B-V)^0_{max} = 0.297 + 0.307 \log P - 0.194\,\Delta V$, $(B-V)^0_{min} = 0.238 + 0.373 \log P + 0.373\,\Delta V$, allow the determination of the color excesses of classical Cepheids to an average accuracy of 0.03 mag. A heuristic argument is given that indicates the basis of these expressions. (auth)

42330 PHOTOMETRIC VARIABILITY OF Ap STARS. Peterson, Deane M. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 161: 685-94(Aug (1970).

It is shown that variations in the abundance of certain metals, particularly silicon and iron, over the surface of a star will produce variations in light that are associated with the rotational period. It is suggested that this is the mechanism for the photometric variability of the Ap stars. (auth)

42331 MODEL ATMOSPHERES FOR B-TYPE STARS WITH BLANKETING BY ULTRAVIOLET LINES. Van Citters, G. Wayne; Morton, Donald C. (Princeton Univ., N. J.). Astrophys. J.; 161: 695-707(Aug 1970).

Nine LTE model atmospheres were computed for surface gravities between log g = 3.0 and log g = 4.5 and for effective temperatures ranging from 14,400° to 25,200°K. The detailed bound–bound opacity of ninety-eight far-ultraviolet lines was added to the continuous opacity of H I, H^-, He I, He II, and free electrons. Fluxes are constant with depth to 2% or better. Tables give the bolometric corrections, depth variations of temperature and pressure, and the spectral distributions of the emergent flux for the models. (auth)

42332 THEORETICAL LINE INTENSITIES. IX. COMMENT ON THE EFFECTIVELY THICK APPROXIMATION. Athay, R. Grant (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 161: 709-11(Aug 1970).

It is shown that, in the effectively thick approximation, emission-line fluxes may exhibit temperature and density dependences that are very different from those found in the optically thin case. Under certain circumstances the line flux may even vary inversely with density. (auth)

42333 RAPID CONTRACTION OF PROTOSTARS TO THE STAGE OF QUASI-HYDROSTATIC EQUILIBRIUM. II. 10, 10^2, 10^3, AND 10^4 SOLAR MASSES WITHOUT RADIATION FLOW. Nakano, Takenori (Kyoto Univ.); Ohyama, Noboru; Hayashi, Chushiro. Progr. Theor. Phys. (Kyoto); 43: 672-83(Mar 1970).

The collapse of opaque protostars of 10, 10^2, 10^3 and 10^4 $M_\odot$ is computed up to the onset stage of quasi-hydrostatic equilibrium in the same way as for 1 $M_\odot$ in a previous paper. The protostars are assumed to retain spherical symmetry. The dissipation of mass motion energy by shock waves is taken into account, but the energy flow in the protostars is neglected for simplicity. It is found that a mass ejected from the surface by the shock wave is negligibly

small for the protostars of 1 and 10 $M_\odot$, while it amounts to 10 or 15 per cent of the total mass for the protostars of 10^2, 10^3 and 10^4 $M_\odot$. The structure of the stars of 1 and 10 $M_\odot$ at the onset stage of quasi-hydrostatic equilibrium is found to be homologous. However, this homology does not extend to the stars of greater masses, in which radiation pressure is important. (auth)

42334 RADIATIVE IONIZATION OF THE FILAMENTS IN THE CRAB NEBULA. Davidson, Kris (Cornell-Sydney Univ. Astronomy Center, Ithaca, N. Y.); Tucker, Wallace. Astrophys. J.; 161: 437-49(Aug 1970).

An attempt is made to explain the observed excitation conditions in the filamentary system of the Crab Nebula in terms of ionization and heating by high-frequency radiation. It was found that it is possible to fit reasonably most of the observed lines by assuming (1) an ultraviolet continuum which smoothly joins the optical and x-ray data and a gas composition in which the number densities of hydrogen and helium are equal, (2) a spectrum which drops off about as steeply as ν^{-2} and therefore does not smoothly fit the x-ray spectrum, or (3) an ultraviolet continuum which smoothly joins the optical and x-ray data plus strong emission-line features near 20 eV. An ultraviolet continuum which is much larger than in these models results in too much ionization in the filaments. The calculations suggest that most of the filaments consist of outer ionized regions with cores of neutral gas. (auth)

42335 ULTRAVIOLET PHOTOMETRY FROM THE ORBITING ASTRONOMICAL OBSERVATORY. I. INSTRUMENTATION AND OPERATION. Code, A. D.; Houck, T. E.; McNall, J. F.; Bless, R. C.; Lillie, C. F. (Univ. of Wisconsin, Madison). Astrophys. J.; 161: 377-88(Aug 1970).

The Wisconsin instrumentation flown in the Orbiting Astronomical Observatory-2 is described. The equipment consists of five filter photometers for measurements in the wavelength interval from 1200 to 4200 Å and two scanning spectrometers covering the region from 1050 to 3800 Å. Operation of the observatory and astronomical instruments is carried out under control from the ground. Those phases of the operation most directly related to the Wisconsin photometric observations are described. An account of the type and quality of data is presented. Discussion of the data will follow in subsequent papers. (auth)

42336 SPECTRAL-LINE FORMATION IN WOLF-RAYET ENVELOPES. Castor, John I. (Univ. of Colorado, Boulder). Mon. Notic. Roy. Astron. Soc.; 149: 111-27(1970).

The escape probability method for treating the transfer of line radiation in a stellar envelope which is in rapid radial expansion is developed, including the effect of radiation from the stellar core. This method is applied to a line formed by a two-level atom, yielding an explicit expression for the line source function. These results are used to calculate three representative line profiles assuming different distributions of absorbing atom density but with a fixed velocity distribution. It is not possible to infer unique values of the parameters from observed line profiles; however, the following qualitative conclusions can be drawn. Flat-topped line profiles, with or without violet absorption, are most naturally produced by an optically thin hollow sphere of emitting material, and rounded lines are the usual result of an optically thick envelope. (auth) (UK)

42337 NATURE OF CONTACT BINARIES. Hazlehurst, John (Univ. of Sussex, Brighton, Eng.). Mon. Notic. Roy. Astron. Soc.; 149: 129-46(1970).

The observed characteristics of the individual components of the W Ursae Majoris systems of low mass are found to be consistent with the primaries being evolved stars, and the secondaries being of age zero. Theoretical models of "contact" systems in which the primary only is evolved were used to calculate a period–colour relationship at constant mass ratio, and this was compared with the observed period–colour relationship of the W Ursae Majoris systems. The agreement of the slopes is satisfactory. The occurrence in Praesepe of a W Ursae Majoris system which is too red to be of age zero, yet too young to be evolved, remains a paradox. (auth) (UK)

42338 STRUCTURE OF W URSAE MAJORIS SYSTEMS. Moss, D. L.; Whelan, J. A. J. (Univ. of Sussex, Brighton, Eng.). Mon. Notic. Roy. Astron. Soc.; 149: 147-65(1970).

The structure of late-type contact binary systems of the W UMa type is investigated using the Lucy (1968) model with a common convective envelope. However more recent opacities than those adopted by Lucy are used. Some differences are found, but it is agreed that no zero age systems with unequal components are to be found with a normal Population I composition. Zero age systems are found for extreme Population I compositions. The effect of changing the mixing length theory is found to be small. Preliminary investigations of the effects of the evolution of the primary from the ZAMS are made, and it may be possible to produce cool systems of low mass ratio this way. However the positions of some observed systems in the period–colour diagram cannot be explained. (auth) (UK)

42339 PRE-MAIN-SEQUENCE MASS TRANSFER IN BINARY SYSTEMS. Whelan, J. A. J. (Univ. of Sussex, Brighton, Eng.). Mon. Notic. Roy. Astron. Soc.; 149: 167-77(1970).

The situation of a fully convective contact binary system is discussed with regard to its mass ratio and to its stability to mass transfer on a short time scale. The contact conditions can only be satisfied by the case of equal stars. Such a system is unstable to mass transfer and tends to a mass ratio of 0.39. Semi-detached systems of mass ratio larger than 0.61 are also unstable. Applying the results to the pre-main-sequence phase of stellar evolution leads to predictions which show qualitative agreement with observations, for the mass ratios of the different types of binary system. (auth) (UK)

42340 INTERPRETATION OF THE COLOUR–COLOUR DIAGRAM OF M92. Bell, R. A. (Royal Greenwich Observatory, Herstmonceux, Eng.). Mon. Notic. Roy. Astron. Soc.; 149: 179-96(1970).

Sandage & Walker (1966) have shown that, at the same B–V, the stars in the subgiant branch of the globular cluster M92 differ systematically in U–B from the stars in the asymptotic branch. They found that the difference was larger than that predicted by continuum fluxes calculated from model atmospheres allowing for the difference in gravity between the branches. A number of synthetic stellar spectra were computed to determine the effect of line absorption upon the colours of these low-metal abundance stars. It is found that, while the slope of the colour–colour curve is altered by the inclusion of line absorption, the amount of such absorption is too small to explain the observed difference in U–B in the original observations. The subgiant branch stars may be divided into two groups and those with the greater ultraviolet excess are also intrinsically the fainter stars of the branch. The models do satisfactorily predict the colours of both the intrinsically brighter subgiant stars and all the asymptotic branch stars. Uncertainty in the transformation of photographically measured colours to the U, B, V system may have caused the B–V colours of the fainter group of subgiant stars to be measured to be redder than the stars actually are. If the B–V colours of this group of stars are reduced by 0.07 magnitudes it is possible for the models to reproduce the then observed slope of the colour–colour curve and to predict the difference in U–B between the subgiant and asymptotic branches. (auth) (UK)

42341 STELLAR AGES AND AN EXTENDED THEORY OF GRAVITATION. O'Hanlon, John (Univ. of British Columbia, Vancouver); Tam, Kwok-kee. Progr. Theor. Phys. (Kyoto); 43: 684-8(Mar 1970).

Some consequences of the time-varying physical constants on stellar ages, as deduced from a modified form of Dirac's hypothesis, are discussed. The variation of the gravitational "constant" is shown to be consistent with a Jordan theory of gravitation. (auth)

42342 RED-GIANT MASS LOSS AND CEPHEID VARIABLES. Tayler, R. J. (Univ. of Sussex, Eng.). Mon. Notic. Roy. Astron. Soc.; 149: 17-24(1970).

Although recent theoretical studies of Cepheid variables were successful in giving a general explanation of the properties of these stars and in showing that variation occurs naturally in the evolution of stars, some difficulties still remain. In particular, the nonlinear calculations of Cepheid light curves only agree with observation if Cepheid masses are about half what is expected from evolutionary tracks of stars of constant mass, and the helium content of Cepheids deduced from theory seems rather high. It is suggested that, if substantial mass loss occurs in the red giant phase of stellar evolution, this might be accompanied by an increase in the helium content of the outer layers of the star, so that the predicted low masses and high helium contents of Cepheids might be explained simultaneously. In addition, mass loss could modify subsequent evolutionary tracks so that, in contrast with the result obtained by Hofmeister (1967), stars with normal metal and helium content might cross the Cepheid strip several times. (auth) (UK)

42343 THEORY OF RAPIDLY ROTATING WHITE DWARFS. Sedrakyan, D. M. (Byurakan Observatory, Erevan. Erevan State Univ. Inst. of Theoretical Astronomy, Cambridge, Eng.); Papoyan, V. V.; Chubaryan, E. V. Mon. Notic. Roy. Astron. Soc.; 149: 25-33(1970).

The structure of rotating white dwarfs was investigated using a second-order perturbation analysis. It is shown that the second-

order corrections are very small and that the first-order perturbation theory gives good results. (auth) (UK)

42344 RECTIFICATION OF P CYGNI LINE PROFILES. Van Blerkom, David (Univ. of Massachusetts, Amherst). Mon. Notic. Roy. Astron. Soc.; 149: 53-7(1970).

In order to separate emission and absorption components of P Cygni type line profiles, a rectification procedure was used by some investigators. This consists of reflecting the observed red wing about line centre and determining the amount of absorption necessary to give the observed violet wing. It is shown that this procedure spuriously introduces the occultation effect into the violet wing and may yield an underestimate of the absorption component and distort its profile. (auth) (UK)

42345 NEW RR LYR VARIABLE WITH VERY HIGH VELOCITY. Alexander, J. B.; Thackeray, A. D. (Royal Observatory, Cape Town). Radcliffe Observatory, Pretoria). Mon. Notic. Roy. Astron. Soc.; 149: 59-64(1970).

The star C.P.D. −74° 214 (BV 1041) has been shown photometrically and spectroscopically to be an RR Lyr variable of type c with short period (0.287 days), very high radial velocity (+304 km s^{-1}) and Preston Index Δs about 7. From the small proper motion an absolute magnitude brighter than +1.9 (M_V) was estimated. (auth) (UK)

42346 USE OF VARIABLE EDDINGTON FACTORS IN NON-LTE STELLAR ATMOSPHERES COMPUTATIONS. Auer, L. H.; Mihalas, Dimitri (Yale Univ., New Haven. Univ. of Chicago). Mon. Notic. Roy. Astron. Soc.; 149: 65-74(1970).

It is shown that by use of variable Eddington factors, the accuracy of difference-equation solutions of transfer problems may be greatly improved with only small additional computational effort. It was found that a direct iterative calculation of the Eddington factors lead to a strongly convergent procedure. The resulting set of equations is of wide applicability to problems involving noncoherent radiative transfer. The method is illustrated by application to the classical grey problem, and to a non-LTE stellar atmospheres computation. (auth) (UK)

42347 DOUBLE-LINED SPECTROSCOPIC BINARY ϵ LUPI (HD 136504). Thackeray, A. D. (Radcliffe Observatory, Pretoria). Mon. Notic. Roy. Astron. Soc.; 149: 75-80(1970).

The first spectroscopic orbit of the 3rd-magnitude double-lined B_3 binary ϵ Lupi was derived. The binary is the brighter component of a close visual binary showing signs of orbital motion in 64 years. The triple system probably belongs to the Sco−Cen association. A fourth distant component of A type was also observed but is probably not physically related. (auth) (UK)

42348 CALCULATION OF THE OPACITY OF STARS UNDER CONSIDERATION OF THE LIGHT ABSORPTION IN SPECTRAL LINES. Nikiforov, A. F.; Uvarov, V. B. (Inst. of Applied Mathematics, Moscow). Dokl. Akad. Nauk SSSR; 191: 47-9 (1 Mar 1970). (In Russian).

Until recently, only the photoionization and the bremsstrahlung have been taken into account when calculating the opacity of stellar matter; however it has been shown that absorption in the lines affects greatly the values obtained. This problem was studied under consideration of the absorption of photons in the spectral lines. The following information must be obtained to calculate the effective absorption cross section and the scattering of photons: the wave function of the electrons of the discrete and conditions spectra and the energy level of the bound electrons; the mean ionization level of the material; probability distribution for the various filling numbers of the electron states and various electric fields created by ions; and the shape and portion of the spectral lines. The Schroedinger equation with the Thomas−Fermi potential was used as the initial approximation to find the wave functions; the discrete energy levels and the corresponding wave functions were derived from the phase method based on the generalization of the quasi-classical Bohr−Sommerfeld equations. The effective cross section of absorption of photons was calculated in the nonrealistic dipole approximation. In some cases, the Stark effect could be neglected. The new opacity calculations were compared with the data of Larsen et al. and Cox et al. The new data were found to be closer to the values reported by Cox. (TTT)

42349 POLARISATION–WAVELENGTH PROFILE OF THE INTERSTELLAR 4430A ABSORPTION BAND. Nandy, K.; Seddon, H. (Royal Observatory, Edinburgh). Nature (London); 227: 264-5(18 Jul 1970).

It is considered that high-resolution studies of the wavelength dependence of interstellar extinction and polarization should provide important tests for proposed interstellar grain models. This is a field in which more detailed study is required. There is also a possibility that the diffuse interstellar bands, the most intense of which occurs at 4430 Å, may be polarized differently from the neighboring continuum, and the amount and nature of such a difference might give a clue to their origin. Using a Wollaston prism at the Cassegrain focus of the 36-inch Edinburgh telescope a polarization profile across the 4430 Å band was obtained, and the technique and preliminary results are described. Observations were made on the star 55 Cyg at a dispersion of 40 Å/mm, and pairs of orthogonally polarized spectra were recorded for three different positions of the Wollaston prism. Instrumental polarization was found to be small. Results are presented graphically for the detailed wavelength dependence of the degree of polarization in the spectral region 4620 to 4380 Å. In the continuum away from the 4430 Å feature the degree of polarization was 2.7%, but changed across the spectral region affected by this feature, the maximum polarization being observed at ~4450 Å. The results were in agreement with earlier measurements. The fact that the polarization changes over the spectral region of the 4430 Å interstellar band implies that the band is polarized differently from the continuum, and the 4430 Å process involves polarization as well as extinction. Explanation of the 4430 Å process in terms of gaseous absorption may not be tenable. An extensive program of measurement is under way. (UK)

42350 ATOMS IN SUPERSTRONG MAGNETIC FIELDS. Cohen, R.; Lodenquai, J.; Ruderman, M. (Columbia Univ., New York). Phys. Rev. Lett.; 25: 467-9(17 Aug 1970).

In magnetic fields B ~10^{12} G, characteristic of neutron-star models for pulsars, the ionization energy of atoms is a few hundred electron volts and is a slowly increasing function of Z. This may greatly affect the nuclear abundances of matter lifted off the stellar surface by electric fields. (auth)

42351 SEARCH FOR PLUTONIUM LINES IN 73 Dra AND OTHER Ap STARS. Kuchowicz, B. (Univ. of Warsaw). Nature (London); 227: 156(11 Jul 1970).

It has been suggested that the peculiar A-type stars, such as 73 Draconis, are secondaries in binary systems in which the primaries exploded as supernovae. The surface material in 73 Dra may thus be regarded as having been transferred from a massive primary in which it had been subjected to rapid neutron capture. All actinide elements up to Fm might have been produced, but would have decayed rapidly, and after ~10^4 yr only Pu, U, and Th would have survived. It is usually believed that any search for the lines of transuranium elements in stars is hopeless, but such lines might be found in Ap stars showing U lines (for example, 73 Dra), and at least for Pu. The most intense Pu lines for which a search might be made are 3000.4, 3907.2, 3985.5, 3989.7, and 4273.3 Å. (UK)

42352 VARIATIONS OF THE MAGNETIC FIELD OF PERIODIC Ap STARS. Renson, P. (Univ., Liege). Mem., Acad. Roy. Belg., Cl. Sci., Coll. 8; 38: No. 5, 1-102(1969). (In French).

The majority of Ap stars, if not all, are periodic. Some mean curves of the periodic variations of the magnetic field, and eventually of the luminosity or of the radial spread are obtained for some of them. For HD 10, 783, 21 Per, HD 32, 633, HR 7058, and 73 Dra, the period is determined more precisely; it was found constant, even in the case where one author had suggested a secular decrease. For γ Equ, a period of 314 days was found. HR 5597 has a period of a little more than one day, but is probably variable periodically (and anharmonically) with a period of the order of 1300 days. The radial speeds of β Cr B shows, moreover, slow and average movements, one component being the magnetic period. Numerous particular verifications find their interpretation in the framework of the binary model. The fluctuations of the observed field with respect to the values indicated by the mean periodic curve are examined for all the known periodic magnetic Ap stars. The mean square deviation increases relatively little with the amplitude of the periodic variation; on an average more or less as a linear function of its square root only. It decreases a little more linearly on an average with the logarithm of the period. Some other possible correlations are studied. Some general results are well interpreted by the binary model, chiefly the distribution of the variation of amplitudes with respect to the periods and the slight correlation found between these latter and the spectral types. (tr-auth)

42353 OBSERVATIONS OF CIRCUMSTELLAR MATTER IN CLOSE BINARY SYSTEMS. Batten, Alan H. Publ. Astron. Soc. Pac.; 82: 574-602(Jun 1970).

Observational evidence for the existence of matter between the components of binary stars is summarized and discussed. Five kinds of evidence are considered: the presence of emission features in spectra; the distortion of velocity curves; spectrophotometry of variable absorption features in spectra; the distortion of light curves; changes of orbital period. The concept of a "characteristic volume" of a binary system is introduced and defined,

and a model for the circumstellar matter is constructed with its help. Three major elements are recognized; cloud, disk, and streams. Estimates of the particle density are collected and presented. In streams the particle density appears to be about 10^{13}/cm^3; in the cloud about 10^{11}/cm^3. This latter value is near the maximum that can be permitted on dynamical grounds. Brief discussions are included of the relative importance of mass loss and mass transfer in the evolution of close binary systems, and of the applicability of particle-dynamics theories to the observations. (auth)

42354 SPECTROGRAPHIC ANALYSIS OF NOVA VULPECULAE 1968, NO. 1. Hutchings, J. B. Publ. Astron. Soc. Pac.; 82: 603-18(Jun 1970).

The results of radial velocity measurements, line identifications, and line profile reductions on medium dispersion spectra of the nova are summarized. The velocity relations and line profiles are discussed together with published light curves of the nova. It is deduced that two main shells were ejected and accelerated away from the photosphere, and geometric and physical parameters are derived for the first 100 days after outburst. The nature of the acceleration is discussed and contrasted with the slow Nova Delphini 1967. (auth)

42355 NEW PARAMETER OF THE GLOBULAR CLUSTER COLOR-MAGNITUDE DIAGRAM. Young, P. Spencer. Publ. Astron. Soc. Pac.; 82: 619-25(Jun 1970).

The parameter C is defined from the slope of the giant branch of the globular cluster color-magnitude diagram. It is found to correlate poorly both with metal content and horizontal branch. Doubt is cast on the feasibility of any two-dimensional classification of the galactic globular clusters, particularly that of Hartwick (1968). (auth)

42356 PHOTOELECTRIC PHOTOMETRY OF NOVA HR DELPHINI 1967. Mannery, Edward J. (Univ. of Washington, Seattle. Cerro Tololo Inter-American Observatory, La Serena, Chile). Publ. Astron. Soc. Pac.; 82: 626-35(Jun 1970).

UBV, photoelectric observations of Nova HR Delphini are presented. These observations form a reasonably complete light curve in V and less complete curves in the other colors. Measurements with an Hα filter were also obtained beginning in July 1968. This nova is of the slow type similar to DO Aquilae. Its absolute magnitude is estimated to have been about -5.9m at maximum and its distance about 910 parsecs. The importance of knowing the response curves of the actual equipment used when observing complex spectra is discussed. (auth)

42357 NEARBY POOR CLUSTER COLLINDER 399. Hall, Douglas S.; van Landingham, Franklin G. (Vanderbilt Univ., Nashville. Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac.; 82: 640-52(Jun 1970).

Collinder 399, a loose cluster of bright stars around 4 and 5 Vulpeculae, is studied with new and old data. Photoelectric UBV magnitudes of 29 stars were obtained, as well as photographic UBV magnitudes of 250 stars, and objective prism spectral classification of 42 stars. Existing radial velocity and proper motion measures and spectral classifications were collected. It is concluded that Collinder 399 is a cluster but contains only six members—five main-sequence early-A stars (+19°4000, +19°4004, +19°4009, 5 Vul, and +19°4019) and one red giant (+19°4017). The cluster is only slightly reddened, with $E_{B-V} = 0.06$m. A fit to the zero-age main sequence (ZAMS) yielded a true distance modulus of about 5.5m; this places Collinder 399 as near as the Pleiades. For this distance there is a complete absence of even possible members between A2 and F5, and the possible members later than F5 are no more numerous than in an outlying control region of equal area; thus it appears that the mean sequence actually ends at about $M_V = +2$m. The five nearby bright B stars once considered members of Collinder 399 are shown to be in the background. Collinder 399 is about 2×10^8 years old, between M 11 and the Hyades in age. It is thus consistent that, in M_V, the giant +19°4017 lies between the giant branch of M 11 and that of the Hyades. (auth)

42358 PLANETARY NEBULAE: PRIME-FOCUS OR COUDE. Bergstralh, Jay T. Publ. Astron. Soc. Pac.; 82: 666-71(Jun 1970).

The relative merits of using prime-focus or coudé spectra to obtain radial velocities of planetary nebulae are examined. Measurement of a few strong lines on the latter appears more efficient as well as more accurate. (auth)

42359 NEW ECLIPSING BINARY CONTAINING A VERY HOT WHITE DWARF. Nelson, Burt (San Diego State Coll., Calif.); Young, Arthur. Publ. Astron. Soc. Pac.; 82: 699-706 (Jun 1970).

A new eclipsing binary was discovered in which one of the stars is shown to be a hot white dwarf. The eclipse is total, and considerable fundamental information about white dwarfs appears to be obtainable. (auth)

42360 CRITERIA FOR THE DISCOVERY OF BETA-CEPHEI STARS ACCORDING TO THE MU-MECHANISM THEORY. Stothers, Richard; Simon, Norman R. (Goddard Inst. for Space Studies, New York). Publ. Astron. Soc. Pac.; 82: 707-15(Jun 1970).

Observational discriminants are proposed to test the μ-mechanism theory of β Cephei stars as advanced by Stothers and Simon (1969). These include: helium and nitrogen overabundances, far-ultraviolet flux excesses (high surface temperature), narrow (occasionally broad) spectral line widths, and binary character. A list of potential β Cep candidates, comprising 24 spectroscopic binaries with spectral type O9-B4 III-V and a large orbital ratio of masses, is compiled for the benefit of observers interested in searching for new β Cep stars. The data thus far accumulated are not in contradiction with, and occasionally positively support, the μ-mechanism theory. (auth)

42361 METAL-DEFICIENT BINARY HR 8899. Abt, Helmut A. (Kitt Peak National Observatory, Tucson, Ariz.); Lee, Paul D.; Perry, Charles L. Publ. Astron. Soc. Pac.; 82: 716-20(Jun 1970).

The discovery of the metallic deficiency and duplicity of HR 8899 makes it one of the very few known metal-deficient stars in a short-period binary system. Orbital elements for this double-lined system are derived, but the minimum masses (0.3 $M_\odot$) are too small to be of interest. The types from the color index (F7), hydrogen lines (F8), and metallic lines (F4-F5) confirm the metallic deficiency. The space motion of the system relative to the local standard of rest is small (35 km/sec). (auth)

42362 DISCOVERIES ON SOUTHERN OBJECTIVE-PRISM PLATES. I. NEW HELIUM-RICH STARS. MacConnell, D. J. (Univ. of Michigan, Ann Arbor); Frye, R. L.; Bidelman, W. P. Publ. Astron. Soc. Pac.; 82: 730-5(Jun 1970).

Six new stars showing unusually strong neutral helium lines are discussed. Two of these, HD 144941 and HD 168785, are quite extreme and may be underluminous. (auth)

42363 1969 PALOMAR SUPERNOVA SEARCH. Kowal, C. T.; Sargent, W. L. W.; Zwicky, F. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac.; 82: 736-40(Jun 1970).

Sixteen supernovae were found at Palomar during 1969. Of these, eight were discovered during the monthly supernova search at the 48-inch Schmidt telescope, one was found with the 18-inch Schmidt, and seven were found on plates of the Palomar sky survey. Parameters are given for the 16 supernovae. (W.D.M.)

42364 ROTATIONAL VELOCITIES OF SOME B STARS. Levato, Hugo; Malaroda, Stella (Observatorio Astronomico, La Plata). Publ. Astron. Soc. Pac.; 82: 741-5(Jun 1970).

Rotational velocities of B-type stars were measured from 138 spectrograms (dispersion 42 Å/mm) secured with the 60-inch Bosque Alegre reflector and 15 spectrograms secured with the 69-inch Perkins reflector (dispersion 40 Å/mm). The rotational velocities were derived from microphotometer tracings of the He I λ4471 line and the Mg II λ4481 line. (W.D.M.)

42365 SPECTROSCOPIC BINARY BM ORIONIS. Doremus, Catharine. Publ. Astron. Soc. Pac.; 82: 745-8(Jun 1970).

A redetermination of the radial velocity curve of BM Orionis indicates that the semiamplitude is much lower than the value derived in 1944. In addition, there is no evidence of a secondary spectrum although the photometry of this system indicates that the two stars are of comparable brightness. (auth)

42366 MEMBERSHIP OF U SAGITTAE IN COLLINDER 399. Hall, Douglas S.; Van Landingham, Franklin G. (Vanderbilt Univ., Nashville. Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac.; 82: 749-52(Jun 1970).

Using the criteria of proper motion, radial velocity, distance modulus, and interstellar reddening, it is concluded that U Sge is not a member of the loose cluster Collinder 399. (W.D.M.)

42367 UBV OBSERVATIONS OF AT HERCULIS. Bookmyer, Beverly B. (Univ. of Arizona, Tucson). Publ. Astron. Soc. Pac.; 82: 757-9(Jun 1970).

UBV observations at AT Herculis obtained on two nights in June 1969 confirm Basu's conclusions that AT Her is neither an RR Lyrae star nor a variable star with a period as short as 0.33d. (auth)

42368 RADIAL VELOCITIES FROM RECENT SPECTROGRAMS OF U OPHIUCHI AND β AURIGAE. Popper, Daniel M.; Carlos, Robert (Univ. of California, Los Angeles). Publ. Astron. Soc. Pac.; 82: 762-5(Jun 1970).

U Oph and β Aur are among the brightest eclipsing binaries. Because of the different results for the masses of these two bright systems by different investigators at various times, a new spectrographic investigation was made on each of them. (W.D.M.)

42369 UBVRI PHOTOMETRY OF INFRARED STARS. Lee, Thomas A. (Univ. of Arizona, Tucson). Publ. Astron. Soc. Pac.; 82: 765-7(Jun 1970).

UBVRI photometric observations are presented for a sample of recently discovered infrared stars. The sample includes three types of stars: T-Tauri stars, B-emission stars, and M supergiants. Most of the objects show emission lines and many have ultraviolet excesses. (auth)

42370 COLLOQUE SUR LE GRAVITATIONNEL PROBLEME DES N CORPS, PARIS, FRANCE, 16-18 AOUT, 1967. (Conference on the Gravitational N-Body Problem, Paris, France, August 16-18, 1967). Paris; Centre National de la Recherche Scientifique (1968). 312p. (In French and English). (CONF-670850).

Papers are presented under the following titles: French contribution to celestial mechanics during the last three centuries; application of summability methods to two- and three-body problems; regularization in stellar dynamics; quasi-periodic solutions in the three-body problem; preliminary numerical model of the solar system (résumé); equation of motion of a particle in a conservative field; accuracy of approximation of the disturbing function in the plane three-body problem; aspects of theory of errors for numerical methods of celestial mechanics; comparison of eleven numerical integrations of the same gravitational 25-body problem; dynamic evolution of simulated N-body systems; escape rate of stars from clusters; numerical integration of collapsing clusters; high central densities in stellar systems; numerical regularization; numerical results on gravitational impact; N-body problem in an external field—application to dynamic application of open clusters; gravitational experiments with a cylindrical galaxy; encounters and escapes [in clusters]; approach to equilibrium of a one-dimensional self-gravitating gas; computer solutions of the gravitational N-body problem; collective motions in a spherical cluster; numerical studies of star systems (résumé); theory of barred and Magellanic spiral galaxies; nonequilibrium statistical mechanics and gravitational interactions; numerical experiments on one-dimensional stellar models; stability of collisionless gravitating systems; runaway centers; and numerical experiments with a very large number of bodies. (L.M.T.)

42371 THEORY OF STELLAR SPECTRA. Cowley, Charles R. Topics in Astrophysics and Space Physics. New York; Gordon and Breach, Science Publishers, Inc. (1970). 270p. $19.50.

Discussions of modern theories of line broadening and the theory of stellar spectra that emphasizes the considerable extent to which the theory has been confirmed by observations were the prime motivations for the book. Topics covered include theory of the line-absorption coefficient, spectral lines in stellar atmospheres, statistical mechanics, quantitative chemical analysis of a stellar atmosphere, theory of line broadening, and quantum-mechanical treatment of pressure broadening. (W.D.M.)

42372 EVOLUTION OF IRON STARS. GRAVITATIONAL CONTRACTION AND THE DECOMPOSITION OF IRON. Nakazawa, Kiyoshi; Murai, Tadayuki; Hoshi, reiun; Hayashi, Chushiro (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 43: 319-33(Feb 1970).

The evolution of iron stars in the phases of gravitational contraction and collapse is studied with an automatic computation method for the stellar masses 2.6 and 10 $M_\odot$. The computation is made for the two alternative cases with and without neutrino production by electron-neutrino interaction. For the stages before the stars become unstable because of the iron-helium phase transition, the features of evolution are essentially the same as those of carbon stars which have previously been computed by Murai, Sugimoto, Hōshi, and Hayashi. Only for the cases with neutrinos, a further evolution has been computed until the central density becomes as high as 1×10^{11} g/cm^3. As soon as the iron-helium phase change occurs in the central region, the stars begin to collapse and the evolution becomes almost adiabatic. It is found that the collapse of the star of 2.6 $M_\odot$ is initiated not by the instability due to electron capture, contrary to the conclusion of Savedoff, Van Horn, and Vila, but by the iron-helium transition. (auth)

42373 INTERFEROMETRIC OBSERVATION OF THE THIN-FILAMENTARY NEBULA NGC 6888. Lozinskaya, T. A. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 98-103(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 122-8(Jan-Feb 1970).

Observations of NGC 6888 were carried out with a high-contrast Fabry-Perot etalon and a contact image converter in the H_α, H_β, and [N II] lines. A splitting of the spectral line profile into several components with a halfwidth of 30 to 40 km/sec was detected, corresponding to the galactic background emission and the approaching and receding parts of the expanding nebula. Besides these components another "diffuse" component was observed with a flat top having a width of some 200 km/sec, and an intensity not exceeding a few percent of the intensity of the "narrow" components. The velocity of expansion of the nebula was determined to be in the range from 55 to 110 km/sec; conclusions are drawn regarding its spatial orientation. The temperature determined from the ratio of the observed halfwidths of the H_α and [N II] (λ = 6583 Å) lines is $T_e = 19{,}000 \pm 4000$°K. The results are in good agreement with the mechanism of formation of the nebula due to outflow of matter from the Wolf-Rayet star HD 192,163, as proposed earlier. (auth)

42374 SPATIAL ORIENTATION OF PLANETARY NEBULAE. Akhundova, G. V.; Seidov, Z. F. (Shemakha Astrophysical Observatory, USSR). Sov. Astron. AJ (Engl. Transl.); 14: 104-6 (Jul-Aug 1970).

Translated from Astron. Zh.; 47: 129-31(Jan-Feb 1970).

The orientation of the axes of planetary nebulae is shown to be random. (auth)

42375 INHOMOGENEITIES OF CHEMICAL COMPOSITION AND PHYSICAL CONDITIONS AT THE SURFACE OF THE Si II Ap STARS CU Vir AND 56 Ari. Khokhlova, V. L. Sov. Astron. AJ (Engl. Transl.); 14: 107-12(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 132-8(Jan-Feb 1970).

The variations in the intensities of Si II lines in the spectrum of Ap stars CU Vir and 56 Ari are investigated in terms of the oblique rotator model. The curves of the intensity variations of Si II lines have two maxima, corresponding to two spots on the surface of the star. The relative intensity of the maxima depends on the excitation potential of the lines. This effect is explained by the temperature difference in the silicon spots. Assuming that the lines are strong in the spots, the temperature difference of the spots is estimated to be $\Delta T \sim 1000$°K for CU Vir and $\Delta T \sim 800$°K for 56 Ari. It is proposed that the spots are related to the presence of a magnetic field. (auth)

42376 NONEQUILIBRIUM β PROCESSES AS A SOURCE OF THERMAL ENERGY OF WHITE DWARF STARS. Bisnovatyi-Kogan, G. S.; Seidov, Z. F. (Inst. of Applied Mathematics, Moscow. Shemakhin Astrophysical Observatory, Baku). Sov. Astron. AJ (Engl. Transl.); 14: 113-16(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 139-44(Jan-Feb 1970).

During the cooling and contraction of a white dwarf star with mass close to the critical mass at T = 0, two-stage reactions of β captures, for example, Fe $\rightarrow$ Mn $\rightarrow$ Cr, in which the second stage proceeds in nonequilibrium, start at the center of the star. This leads to a release of thermal energy, a slowing down of the contraction, and an increase in the evolution time of the star in the mass range $\Delta M/M \approx 2 \times 10^{-4}$ near the limiting mass. For these stars the presence of Debye degeneracy is not important and the time of cooling of the star at temperatures smaller than the Debye temperature is close to the classical. (auth)

42377 EMISSION FROM THE WAKE OF A SHOCK WAVE IN STELLAR ATMOSPHERES. Golin'ko, V. I. (Odessa Astronomical Observatory). Sov. Astron. AJ (Engl. Transl.); 14: 117-19(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 145-8(Jan-Feb 1970).

The temperature gradient behind a shock-wave front is determined. It can be used for a quantitative interpretation of the emission spectrum of stars in whose atmospheres shock waves propagate. (auth)

42378 SELECTION EFFECTS IN THE DISCOVERY OF SPECTROSCOPIC BINARY STARS AND THE INTERPRETATION OF THE B EFFECT. Brazhnikova, E. F. (Lenin Pedagogical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 120-9(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 149-61(Jan-Feb 1970).

A theoretical demonstration is provided for the hypothesis that if the center of mass of a spectroscopic binary star moves relative to the cosmic dust such that the periastron of the bright component falls in the apex direction of the motion, then an accumulation of optically effective cosmic dust will develop near the binary system, serving to screen it preferentially from an observer located at its antapex. This hypothesis has several implications: 1) stars with periastra behind the plane of projection will tend to predominate (the B effect), and the effect will be enhanced for stars with a radial velocity $v_r < 0$; 2) stars with periastra in front of the plane of projection will predominate if $v_r > 0$; 3) stars

with periastra at the antapex will predominate whatever the sign of v_r. These conclusions are all reliably supported by the observational values quoted in Bečvář's catalog (389 orbits), together with Batten's catalog. The probability that the observed periastron distribution is a random one is only 10^{-2} to 10^{-3}. (auth)

42379 STRUCTURE OF THE CLUSTER M39. Artyukhina, N. M. (State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 130-2(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 162-5(Jan-Feb 1970).

On the basis of proper motions previously obtained, radial distributions of the apparent density of probable cluster members brighter than 11.2^m, chosen by their proper motions, are plotted. It is shown that the cluster consists of a nucleus (~22.5′ in radius) and a corona (~1.2° in radius). Roughly 50% of the cluster members brighter than 11.2^m are located in the corona. The structure of M39 does not differ from that of typical open clusters like Praesepe and the Pleiades. The discovery that this star-poor cluster, situated against the dense, inhomogeneous background of the Milky Way, has a corona can be considered an important support for the hypothesis that all open clusters have a similar structure. (auth)

42380 EVOLUTION OF A PROTOSTAR CLUSTER IN THE STANDARD 25-BODY PROBLEM. Aleshin, V. I.; Kaplan, S. A. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 14: 6-10(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 10-15(Jan-Feb 1970).

The results of the numerical solution of a system of equations describing the motion in a cluster of 25 protostars (mass condensations), including both Newtonian gravitational interaction and the influence of gas and magnetic pressure on the motions are reported. (auth)

42381 SUPERMASSIVE STARS FORMED BY INELASTIC EVOLUTION OF STELLAR SYSTEMS. Gurevich, L. E. Sov. Astron. AJ (Engl. Transl.); 14: 25-32(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 32-42(Jan-Feb 1970).

A concentrated stellar system that is evaporating, and thus contracting, comes to a state in which inelastic contact collisions of stars are more significant than their gravitational interaction when they are approaching each other. In the collisions of the stars, gas is ejected; at the beginning of the process this gas probably condenses not into many stars, but into a single central star which with the accumulation of gas becomes supermassive. The structure of such a star is investigated, and it is shown that convective mixing must occur in the main mass of the star. After the stationary luminous flux of the supermassive star has been established, the absorption of hydrogen by the star ceases. Heavy elements must sink toward the center, and the light elements must be "blown out." A more- or a less-rapid rupturing of the envelope is possible, depending on the chemical composition. (auth)

42382 OPTICAL APPEARANCE OF A COLLAPSING STAR IN TERMS OF THE SCALAR-TENSOR THEORY OF GRAVITATION. Nariai, Hidekazu (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 43: 334-46(Feb 1970).

The optical appearance of a collapsing star in terms of the scalar-tensor theory of gravitation is studied in comparison with Ames and Thorne's general relativistic treatment. It is shown that the expressions for the spectral shift, the intensity, and the net flux in the rim region of its optical disk which is brightest and bluest are qualitatively of the same form as their counterparts in Ames and Thorne's analysis. This means that the optical appearance is not so different from that predicted by them, in spite of the fact that the hypersurface R = 2M is observable to a distant observer in our space–time. For the observational test of the scalar–tensor theory relative to the general theory of relativity, it is more preferable to examine both the time dependence of the spectral shift $z(T_0)$ and the z dependence of the intensity I(z) for the radiation emitted from the central region of the optical disk. (auth)

42383 CATALOGUE OF EARLY-TYPE STARS WHOSE SPECTRA HAVE SHOWN EMISSION LINES. Wackerling, Lloyd R. (Northwestern Univ., Evanston, Ill.). Mem. Roy. Astron. Soc.; 73: 153-319(1970).

A catalogue of 5326 early type emission-line stars is presented and its content is briefly analysed. The catalogue provides collated designations, positions, and an indication of the availability of spectral and photometric data for stars of classes W, O, B, A, and F. The surface distribution of the objects along the Milky Way and the details of concentrations near some OB associations are briefly presented. (auth)

42384 NUCLEAR PHYSICS OF NEUTRON STARS. Cameron, A. G. W. (Yeshiva Univ., New York). pp 551-70 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).

See CONF-690804.

Pulsars have been fairly definitely identified as rotating neutron stars. A theoretical model for the neutron stars is developed in which hyperons appear as one of the components of the high-density inner region of the stars. The outer surface regions can be described by applying the laws of ordinary nuclear physics to a nuclear composition which is more neutron-rich than that encountered in the laboratory. (auth) (Canada)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 42843 and 43043.

42385 (CSIRO-Trans–10121) SMALL ANGULAR SIZE SOURCE IN CRAB NEBULA. Matveenko, L. I.; Lotova, N. A. Translated by M. A. Hintze (Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia), from Astron. Tsirk.; No. 495, 1-2(Feb 1969). 2p. Dep. CFSTI (U. S. Sales Only).

The distance to a pulsar in the direction of the Crab Nebula was evaluated from polarization investigations, and it was verified as being in the Nebula. The anomaly of the sizes of the flickering source compared with the angular size of a neutron star at this distance, is explained by the model of a rotating neutron star, radiating in a comparatively small cone. (Australia)

42386 (CSIRO-Trans–10122) MECHANISM OF RELATIVISTIC ELECTRON INJECTION IN CRAB NEBULA. Shklovskii, I. S. Translated by M. A. Hintze (Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia), from Astron. Tsirk.; No. 495, 2-4(Feb 1969). 3p. Dep. CFSTI (U. S. Sales Only).

The source of injection of relativistic particles in the Crab Nebula is postulated as being the pulsar within it. (Australia)

42387 (CSIRO-Trans–10123) PULSAR CP0808 METRE WAVELENGTH RADIATION. Alekseev, Yu. I.; Vitkevich, V. V.; Shitov, Yu. P. Translated by M. A. Hintze (Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia), from Astron. Tsirk.; No. 495, 4-5(Feb 1969). 2p. Dep. CFSTI (U. S. Sales Only).

Results of observations of CP 0808 indicated 3 subpulses at 62 Mc/s and 2 subpulses at 80 Mc/s. The period mean value was 0.05364 ± 0.00001 sec. Frequency drift at 81.5 Mc/s was 11.42 Mc/s, which conflicts with some previously cited data. (Australia)

42388 OBSERVATIONS OF RADIO SOURCES NEAR 2 f.u. AT 408 MHz. Hunstead, R. W. (Univ. of Sydney); Jauncey, D. L. Mon. Notic. Roy. Astron. Soc.; 149: 91-100(1970).

Accurate radio positions, optical identifications, angular size estimates, and flux densities, are presented for a sample of 35 sources, 33 of which are near 2.0 f.u. at 408 MHz. Comparison with stronger sources found at the same frequency showed no significant dependence of the small component fraction or of the spectral index distribution on flux density. The weaker radio galaxies were generally found to be also fainter optically. In contrast the mean apparent magnitude for the quasi-stellar radio sources appeared to be independent of the radio flux density. The relative proportion of galaxies and quasi-stellar radio sources was found to be very similar to that found for the stronger sources. The high density of background galaxies found near the identified galaxies and the blank fields draws attention to the need for caution in assessing the validity of identifications associated with faint optical objects. (auth) (UK)

42389 BEAMING OF RADIO WAVES FROM PULSARS. Smith, F. G. (Nuffield Radio Astronomy Labs., Jodrell Bank, Eng.). Mon. Notic. Roy. Astron. Soc.; 149: 1-15(1970).

The radio pulses from pulsars are formed by a beam of directed emission which sweeps across the observer. The structure of individual pulses, rather than the average pulse shape, is considered to be important. The beam could be formed by an anisotropic emission process, such as synchrotron radiation, or by anisotropic propagation, or by the relativistic effect of the rapid orbital motion of the source. Pulse shapes to be expected from synchrotron radiation and from the relativistic effect were calculated. Comparison with observed widths and polarization of radio pulses suggests that they are formed by the relativistic effect, and that the radiation mechanism is through some process akin to cyclotron radiation. (auth) (UK)

42390 MAPS OF SIX EXTRAGALACTIC RADIO SOURCES AT 5 GHz. Mitton, Simon (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 149: 101-9(1970).

3C 123, 196, 247, 275.1, 295, and 336 were mapped with the Cambridge One-Mile telescope at a frequency of 5 GHz, with a resolution of 6.5 arc sec. The maps provide new positional information and physical data for the six sources. 3C 123, 247, and 336 are resolved into double sources, and an identification of 3C 247 with a galaxy is suggested. A comparison of the structural information derived from the 5 GHz work with previous observations using long baseline interferometers, and with observations of interplanetary scintillation, is made. Morphologically the quasi-stellar source 3C 336 is shown to be similar to 3C 47, and this is interpreted as further evidence for continuing or recurring activity in quasi-stellar sources over periods of at least 10^6 years. (auth) (UK)

42391 FLUX DENSITIES AND VARIABILITY OF RADIO SOURCES AT WAVELENGTHS OF 0.95 AND 1.65 CENTIMETERS. Hobbs, Robert W.; Waak, John A. (Naval Research Lab., Washington, D. C.). Astrophys. J.; 161: 793-5(Aug 1970).

Measurements of eight radio sources at 0.95 cm and eleven sources at 1.65 cm were made by using the 85-foot antenna of the Naval Research Laboratory. Flux densities at epoch 1969.4 are given relative to Jupiter. The source VRO 42.22.01 is found to increase by 115% and 50%, respectively, at these two wavelengths in a time scale of two months. (auth)

42392 HIGH-PRECISION RADIOFREQUENCY SPECTRUM OF $^{14}N^{16}O$. Neumann, Richard M. (Harvard Univ., Cambridge, Mass.). Astrophys. J.; 161: 779-84(Aug 1970).

Λ-doubling transitions were observed in both Ω components of $^{14}N^{16}O$ in its $^2\Pi$ ground state. Hyperfine constants and predicted frequencies are presented. (auth)

42393 RICH ABSORPTION SPECTRA OF THREE QUASI-STELLAR OBJECTS. Bahcall, John N. (Inst. for Advanced Study, Princeton, N. J.); Feldman, Uri. Astrophys. J.; 161: 389-98(Aug 1970).

The absorption spectra of PHL 938, TON 1530, and PKS 0237-23 were searched in a systematic way for redshifts that may include lines arising from metastable states, interstellar lines, and Balmer lines. A search for blueshifts was also carried out for the first time. The statistical significance of the redshift system z = 0.6128 in PHL 938 was established by analyzing random-number spectra. It is shown that the electron density is less than 50 $T_4^{\frac{1}{2}}$ cm^{-3} in the vicinity of this absorption system and that the minimum separation between PHL 938 and the absorption system is about 100 pc. A critical test of the idea that normal galaxies produce the absorption lines is described. Nine interstellar lines observed in the spectra of stars in the Galaxy might appear in the observationally accessible region between 4956 and 6400 Å for the redshift system z = 0.6128 of PHL 938. (auth)

42394 POWER SPECTRUM OF 3C 273 LIGHT FLUCTUATIONS. Terrell, James; Olsen, Kenneth H. (Los Alamos Scientific Lab., N. Mex.). Astrophys. J.; 161: 399-413(Aug 1970).

The fluctuations in optical luminosity of the quasi-stellar object 3C 273 were analyzed, using new methods of obtaining information from the power spectrum, to determine whether the light must necessarily come from a single source. No convincing evidence of a long-term (~10-year) periodicity was found, and the case of randomly occurring overlapping light pulses ("shot noise") is thus not ruled out. If the fluctuations are due to such random pulses, the power spectrum indicates that individual outbursts with an average effective pulse length of 3.2 ± 1 year occur at an average rate of 15 ± 5 per year, giving an average of 48 ± 5 pulses overlapping. This would lead to the observed fluctuations in luminosity, ±14% rms. Random signals with these characteristics were generated, and were found to have properties very similar to the 3C 273 signal. The observed trend of the luminosity, which has decreased by ~21% in 80 years, is shown to be consistent with such a random signal. Thus both single- and multiple-source models of QSOs are consistent with the luminosity data for 3C 273. (auth)

42395 POLARIZATION OF RADIO SOURCES. II. FARADAY EFFECT IN THE CASE OF QUASI-TRANSVERSE PROPAGATION. Pacholczyk, A. G.; Swihart, T. L. (Univ. of Arizona, Tucson). Astrophys. J.; 161: 415-18(Aug 1970).

Under the conditions of quasi-transverse propagation of electromagnetic waves in a magnetoionic plasma, the effect analogous to Faraday rotation in the quasi-longitudinal case (which is called Faraday pulsation) can produce a large elliptical polarization of radiation that originally was linearly polarized. Therefore, the presence of elliptical polarization in the radiation cannot serve as a means for distinguishing between a synchrotron mechanism with high-energy electrons and any other type of emission process in radio sources in which conditions suggesting quasi-transverse propagation (large magnetic fields) may take place. The Faraday pulsation has a wavelength dependence through which it can be identified. (auth)

42396 STATISTICAL INVESTIGATION OF DISTRIBUTION OF PULSARS IN SPACE. Gold, T.; Newman, H. M. (Cornell Univ., Ithaca, N. Y.). Nature (London); 227: 151-2(11 Jul 1970).

Fifty pulsars are known and the distribution of their angular coordinates in the sky, in relation to the galactic plane, can be used to infer information about their distribution in distance. In the analysis presented, the 50 pulsars are divided into two groups, with periods longer and shorter than 1 sec, giving 35 pulsars in the short period group and 15 in the long period. The assumption is then made that the pulsars in each group have the same intrinsic intensity, and a calculation can then be made of the distribution function with galactic latitude that would be expected for a given value of the maximum distance to which the pulsars in each group can be seen. Because of the small numbers, however, it is much more instructive to compare the actual distribution not with an idealized distribution function but with distributions computed by a Monte Carlo method using equally small numbers as in the real case. A histogram is shown indicating how the distribution evolves as the maximum distance to which a pulsar can be seen is increased, from which it is clear that the observed distribution is best approximated by assuming a maximum distance of 2 to 5 kpc. Similar considerations for the long-period pulsars show that distances > 500 pc give distributions that exhibit too high a degree of concentration toward the galactic plane to correspond well with the observations. The distances estimated are compared with those estimated using the criterion of the observed dispersion measures of the pulsars, and it is concluded that it is not unreasonable to suppose that the pulsars with the largest dispersion measures are more distant, and hence intrinsically more luminous, than the average of the objects in the group. A large spread in intrinsic intensity within each group must be expected, and will have the consequence that calculations ignoring this effect will give too high a value of the electron density in space. The data obtained should thus be taken as an upper limit for this quantity. The limited data make it clear that long-period pulsars as a group are intrinsically much fainter than short period pulsars, and comparison with calculations gives distance estimates not likely to be in error by a large factor. (UK)

42397 NEW ANALYSIS OF THE RADIO SOURCE COUNTS. Davidson, W. (Univ. of Otago, Dunedin, N. Z.). Nature (London); 227: 357-9(25 Jul 1970).

A new scheme is described for the overall evolution of extragalactic radio sources. Attempts to relate the counts of these sources to cosmological models have not been entirely successful; more are incomplete, and others have serious detail defects. Furthermore, these attempts have failed to establish the relative importance of the concepts of "density evolution" and "luminosity evolution" in the cosmic history of the radio source population. The studies described were undertaken in an attempt to resolve this difficulty. The analysis was based on the Cambridge counts of radio sources, made at 178 MHz and 408 MHz, with lower sensitivity limits of 0.27 flux units and 0.01 flux units, respectively. Model predictions were compared with experimental observations, and good agreement was found. It is concluded that "luminosity evolution" and not "density evolution" is the dominating influence explaining the radio source counts. (UK)

42398 PULSATIONS IN X RADIATION OF THE CRAB NEBULA. Ducros, G.; Ducros, R.; Rocchia, R.; Tarrius, A. (CEN de Saclay, Gif-sur-Yvette, France). Nature (London); 227: 152-4(11 Jul 1970).

Final results of observations of pulsations in x-ray flux in the 2.5- to 30-keV range coming from the direction of the Crab Nebula are presented. The experimental data emanated from a rocket launched on Dec. 23, 1968 from French Guiana, carrying a proportional counter, and covered a period of ~210 sec. From data obtained in the radio, visible and x-ray bands the geocentric period of NP 0532 at the time of the observations was calculated as T = 33.09297 msec. It was observed that the pulsation had a double structure composed of two peaks about 13 ms apart, similar to that observed at radio, optical, and low energy x-ray wavelengths; also, that the first peak was of greater amplitude than the second. Two almost identical secondary peaks were also observed, again ~13 ms apart. An important question is the ratio of the pulsed radiation to the total radiation background, which appears to vary above 2 keV; a spectral analysis of this ratio is given, together with data on the relative amplitude of the two pulsation peaks. The widths of the two peaks were found to be 1 ms and 2.5 ms. In a profile for 33 channels the pulsed part above the continuous level represented 11.3 ± 1% of the total radiation coming from the Crab Nebula. The pulsed fraction increased from 7.9% at 4 keV to 16.7% at 20 keV, and a

pulsed fraction independent of energy was incompatible with the results, which appeared to show that the pulsation ratio was smaller at low energies than at energies >10 keV, at which point it reached an approximately constant value of ~0.15. It is assumed that there was a break in the spectrum of the pulsed part at ~10 keV, the pulsation ratio then remaining almost constant at high energies. Such a break may be caused by the emission mechanism and/or interstellar dust. It is stated that the assumption of an energy-independent pulsation ratio may, however, be justified if it is considered that the pulsation and continuum are both produced by the same electron spectrum in different magnetic fields. If it is assumed that interstellar dust is composed of fine grains of ice spread evenly between the source and the Earth and the radii are distributed according to a Gaussian law with a mean value of 0.5 μm, then the pulsation ratio at 120 keV should be ~0.15. During the time the Crab Nebula was under observation the pulsar NP 0527 was also in the field of the detector, and another detector was also pointed in the direct of CP 0329; no pulsations were observed for these pulsars. (UK)

42399 EXPERIMENTAL METHOD FOR DISTINGUISHING PULSAR MODELS. Roe, P. E. (Cambridge Univ., Eng.). Nature (London); 227: 154-6(11 Jul 1970).

It is suggested that the fact that Huggin's principle is not valid in large gravitational fields may give rise to some related experimental effects. As a consequence of the hypothesis that light travels along null geodesics if a pulse of radiation is emitted from a distant object, a single pulse of radiation would be expected to be seen. This hypothesis, however, is only an approximation, and is not valid in curved space–time. An emitted pulse is seen as two pulses; the second pulse has an amplitude φ/C^2 relative to the first pulse, where φ is the gravitational potential of the point of emission. The quality φ/C^2 is not negligible on the surface of a neutron star, and such an effect may be observable. These findings are subjected to mathematical analysis in the context of Huggin's principle and Riemannian space, and the possibility of observing the effects in the curved space–time associated with a dense massive object, such as a pulsar, is discussed. An important feature is the rotation of the angle of polarization, as observed for PSR 0833-45; it would be expected that the degree of polarization would change through the duration of a pulse. Rotation of the polarization vector should be searched for a radio wavelengths and the rate of change of polarization angle measured. The technical requirements are little greater than what has already been achieved. It is necessary to measure degree of polarization to 1% at time intervals of twentieths of ms. The observation of any effect at all would be sufficient to provide evidence in favor of a compact rotating model the source of radiation of which is on its surface. (UK)

42400 NORTHERN GALACTIC RADIO SOURCES. Milne, D. K. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Aust. J. Phys.; 23: 425-44 (Jun 1970).

A catalogue is presented at 97 supernova remnants and a distance scale, based on the radio-surface brightness, is established for this type of radio source. The data are used to derive the galactic distribution and to test theories relating to the evolution of these objects. (Australia)

42401 PULSAR HUNTER: TESTS ON NP 0532. Chiu, Hongyee (Goddard Inst. for Space Studies, New York).; Lynds, R.; Maran, S. P. Publ. Astron. Soc. Pac.; 82: 660-5(Jun 1970).

An instrument is described which makes it possible to search for optical pulsars in the fields of radio pulsars for which positions are not particularly well known. The successful performance of the instrument on NP 0532 is shown. (auth)

42402 OXYGEN ABUNDANCE AND ELECTRON TEMPERATURE OF NGC 604. Peimbert, Manuel (Univ. Mexico, Mexico City). Publ. Astron. Soc. Pac.; 82: 636-9(Jun 1970).

Based on photoelectric observations, an electron temperature of 9600°K ± 650°K and an oxygen-to-hydrogen abundance ratio very similar to that of the Orion Nebula are derived for NGC 604. (auth)

42403 X-RAY PHOTOMETRY OF M1. Acton, L. W. Univ. of Hawaii, Honolulu); Catura, R. C.; Fisher, P. C.; Roethig, D. R. Publ. Astron. Soc. Pac.; 82: 653-9(Jun 1970).

A new observation of the x-ray emission of M1 is compared to other published measurements. In the energy interval 2 to 25 keV, the power law spectral distribution $N(E) = 8.5E^{-2\vartheta}$ photons cm^{-2} sec^{-1} keV^{-1} appears to describe the x-ray emission of M1 within a 10% accuracy. (auth)

42404 INVERSE COMPTON PROCESS IN QUASARS AND SEYFERT-TYPE NUCLEI. Takarada, Katsuo (Nayoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 43: 303-18(Feb 1970).

The inverse Compton spectral power of the infrared source, which is optically thick to its own radiation due to the synchrotron self-absorption process, is calculated. A radio source of a single ensemble of relativistic electrons and magnetic fields is considered. These electrons emit synchrotron radiation, the high-frequency part of the high-frequency cutoff of which is observed in the infrared frequency range. A small fraction of the synchrotron photons suffers the inverse Compton scattering by the same ensemble of relativistic electrons. The scattered radiation is observed in the optical range. On the basis of this interpretation, the physical parameters of the infrared and optical source of 3C 273 are determined. A possible role played by the inverse Compton process is discussed for Seyfert-type nuclei. (auth)

42405 PULSAR AP 2015: 21cm LINE ABSORPTION PROFILE. Encrenaz, P.; Guelin, M. (Observatoire, Meudon, France). Nature (London); 227: 476-7(1 Aug 1970).

It is stated that measurement of the 21-cm line absorption in pulsars may lead to the setting of upper and lower limits for their distance using a galactic rotation model. Knowledge of the distance of pulsars and measurement of their dispersion and absorption profiles also provide information on interstellar electron and natural hydrogen densities. In the experiment described the absorption spectrum of AP 2015 + 28 was measured with the Nancay transit telescope with a resolution of 12.7 km/sec. Absorption was observed at least up to 14 km/sec and this pulsar must be located further than 1 kpc. The observations were made on Dec. 13, 1969 and February 13, 1970, and the 21-cm line absorption spectrum in front of AP 2015 is shown and compared to the emission profile in the same direction. The spectrum shows a large and wide feature at positive velocities, and there was significant absorption up to 17^{+5}_{-3} km/sec. This velocity is too high to be due to random motions of local hydrogen clouds and must result chiefly from the differential galactic rotation. The 21-cm emission profile in the direction of AP 2015 is very faint at negative velocities, and it was not possible to derive an upper limit to the distance from the absence of absorption in this part of the spectrum. There is evidence from the absorption spectra that a neutral hydrogen model with uniform density and temperature is not valid in this region. Using the lower limit of 1 kpc for the distance of AP 2015, the lower limit of the mean electron density is calculated as 0.015/cm^3 in the direction of the pulsar; this is significantly smaller than usually assumed for the interstellar medium. (UK)

42406 OPAQUE RADIO SOURCES NEAR THE GALACTIC EQUATOR. Mac Donell, D. G.; Bridle, A. H. (Queen's Univ., Kingston, Ont.). Nature (London); 227: 582-3(8 Aug 1970).

Studies of the continuum spectra of discrete radio sources have provided examples of sources with "opaque" microwave spectra, in which the flux density has a maximum at a frequency >3 GHz. At least two classes of objects show such spectra—compact extragalactic sources, frequently identified with QSOs or nuclei of galaxies—and galactic H II regions with high electron densities. The 46-m paraboloid at Algonquin was used to search for more sources with opaque microwave spectra within 10° of the galactic equator and between galactic longitudes 15 and 235°. Observations were made at 3.24, 6.63, and 10.63 GHz. DW 0224 + 67, DA 193, and DW 0827-11 were found to have opaque spectra with maximum flux density at >3 GHz. The sources were observed on several occasions between Feb. 1969 and Feb. 1970, and observations were made in linear polarisation at position angle 0°. The observed flux densities and positions of the three sources are shown tabulated, and the mean flux densities at each frequency are shown plotted to indicate the forms of the radio spectra. There were indications that the intensity of the source DW 0224 + 67 decreased between February 1966 and April 1969 at 1.4 GHz, but no evidence that the source was variable at the higher frequencies between February 1969 and February 1970. The radio spectrum suggests that the source has two components—an opaque component that dominates at 72 GHz and a component with spectral index ~0.4 that dominates at <1 GHz. The presence of the low-frequency component, and the apparent variability observed at 1.4 GHz, imply that the source is not an H II region; it is probably a compact extragalactic source. The spectrum of DA 193 suggests that it might be a distant or obscured H II region, or may be extragalactic. The spectrum of DW 0727-11 suggests that this source is not an opaque H II region, and its emission mechanism may be nonthermal; its intensity near 5 GHz may have increased between July 1968 and March 1969, and it is probably extragalactic. (UK)

42407 RUDERMAN'S THEORY OF VORTEX-LATTICE VIBRATIONS IN PULSARS. Fetter, A. L. (Stanford Univ., Calif.); Stauffer, D. Nature (London); 227: 584-5(8 Aug 1970).

Ruderman (Nature 225: 619 and 838 (1970)) suggested that the observed modulation of the rotation frequency of the Crab pulsar, with a period ≈4 months, arises from waves in the triangular

lattice of quantised vortex lines expected to occur in pulsars. The calculations, however, neglected mutual friction between the vortices and the normal component (essentially electrons and protons). In the present communication these frictional effects are estimated, and appear to be considerable. The mutual friction not only damps the vortex oscillations, but also acts to bring the vortices to a new equilibrium after a sudden small change in angular velocity of the normal component. Amongst conclusions reached is that Ruderman's suggested vortex oscillations might occur in the Vela pulsar but not in the Crab pulsar, where the friction is too strong. The possibility of normal component oscillations (shear waves) is also considered. Overdamping may occur in the Crab pulsar, the damping being caused probably by scattering of electrons and protons at the vortex core. A difficulty associated with the three-dimensional nature of the pulsar is also pointed out. The spherical geometry of the pulsar leads to a further problem. If the theory can describe a sphere, the low frequency modes derived from the strict two-dimensional theory could require that the vortices slide along the pulsar boundary in such a way that the increased length from bending of the lines just cancels the shortened length arising from the curved surface. Since, however, the pulsar probably has a rigid crust, the vortex lines should be pinned to the surface. Thus, there are two different arguments against interpretation of the low-frequency wobble in the Crab pulsar as a long-wavelength oscillation of the superfluid vortex lattice. (UK)

42408 QUASAR ABSORPTION LINES AND RADIO POLARISATION. Gardner, F. F.; Whiteoak, J. B. (CSIRO, Sydney). Nature (London); 227: 585(8 Aug 1970).

It has been reported that the mean linear polarisation at 49 cm is lower for quasars with absorption line spectra than for those with pure emission line spectra, and it was suggested that depolarisation occurs as a result of Faraday rotation in the same regions as are responsible for the absorption lines. This effect was examined in more detail for the two classes of quasars with $Z > 1.25$, using the mean values of percentage polarisation at 6, 11, and 49 cm. Differences were found to be comparable at all wavelengths. It is concluded that the polarisation difference is due to a lower intrinsic polarisation for the absorption line sources, rather than to a larger Faraday depolarisation, since the latter would increase by at least 66 times between 6- and 49-cm wavelength. The difference would contribute in part to the observed decrease of polarisation with redshift since the relative abundance of absorption line sources for redshifts >1.25 is about seven times that at lower redshifts. (UK)

42409 CIRCULAR POLARISATION OF QUASARS AT λ 49 cm. Gilbert, J. A.; Conway, R. G. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London); 227: 585-6(8 Aug 1970).

It has been suggested that radio sources that emit by the synchrotron process may show a small amount of circular polarisation, as well as the well-known linear polarisation, but previous measurements failed to detect such polarisation. Studies are described on 20 quasars at λ 49 cm (610 MHz) using the Mk I and II telescopes at Jodrell Bank as an interferometer with a spacing of 865 wavelengths, and the polarisation results for the 20 quasars and two radio galaxies, after correction for instrumental polarisation, are shown in tabular form. The sources were all observed on at least two occasions and, for most, the total integration time was >6 hrs. It was indicated that CTA 102 and PKS 2203-18 showed significant circular polarisation, and that PKS 1127-14, VRO 42.22.01 (BL Lac), and PKS 1510-08 are also possibly polarised. The remaining sources appeared to be unpolarised at the 0.1% level. It was found that the measured circular polarisation was not correlated with the degree of linear polarisation. The magnitude of circular polarisation is shown plotted against spectral index, and a highly significant correlation was found, in the sense that only sources with very flat or inverted spectra at λ 49 cm showed circular polarisation. In view of this correlation it is believed that the measured polarisation of VRO 42.22.01, 1127-14, and 1510-08 is real. It also appeared from the observations that some of the quasars had magnetic fields of 10^{-3} G or higher. Because the quasars with a flat spectral index tend to be those with small linear dimensions and high energy density it is not surprising that those with circular polarisation should all be of this type. The converse is, however, not true, as some compact sources are not significantly polarised. It is pointed out that a coherent plasma mechanism, and not the synchrotron mechanism, may be the true explanation of the observed circular polarisation. (UK)

42410 RADIO WAVES FROM GRAINS IN H II REGIONS. Hoyle, F.; Wickramasinghe, N. C. (Cambridge Univ., Eng.). Nature (London); 227: 473-4(1 Aug 1970).

There is considerable evidence for the presence of dust grains in H II regions of the Galaxy, particularly within associations of young stars. This dust may show by scattering starlight, and it may also give rise to infrared radiation. The total mass of dust in a typical case could be large, amounting to ~1% of the mass of the associated stars. The process envisaged for emission of radio waves by dust involves photoelectric charging of dielectric grains by uv light, rotation of grains through interaction with stellar photons, and radiation by rotating dipoles. Dust may also exist in large quantities near the center of galaxies. A strong uv source has been reported at the center of M31, and hence the same process could occur in the nuclei of galaxies. This is considered in general terms in relation to the radio emission from dust embedded in H II regions, and a mechanism is described whereby the optical radiation from stars embedded in dust-filled H II regions may be converted to microwave and long-wave radio emissions. (UK)

42411 OBSERVATION OF PULSARS AT 1420 MHz. STUDY OF THE FINE STRUCTURE OF THE PULSES. Encrenaz, Pierre; Foy, Francoise; Guelin, Michel (Observatoire de Paris, Meudon, France). Compt. Rend., Ser. B; 270: 1585-8(15 Jun 1970). (In French).

The first results obtained from a systematic study of pulsars at 1420 MHz carried out since December 1969 are given. The measurements led to the specification of the average fine structure of the pulses in decimeter waves. The spectra of the components of a pulse are shown to be not always identical. (tr-auth) (France)

42412 PULSAR RADIATION MECHANISMS. Sturrock, P. A. (Stanford Univ., Calif.). Nature (London); 227: 465-70(1 Aug 1970).

Pulsars are considered to possess strong magnetic fields of the order 10^{12} G, and it is believed that the radiation is associated with the magnetic poles. Explanation of the radiation is coupled inextricably with an understanding of the magnetic field and plasma configuration associated with rotating neutron stars. The topology of the magnetic field is discussed, and an estimate of the current distribution is arrived at. Knowledge of the current distribution at the polar caps leads to a knowledge of the electric field in these regions. Finally, a knowledge of the magnetic field, electric field, and particle flux at the polar caps enable a study of the plasma processes that occur and calculation of the radiation. Among matters considered are the magnetic field between star and light cylinder, the electric field at the polar cap, the radiation reaction, pair creation by γ-ray annihilation, plasma flow at electron polar zones, radio emission, incoherent radiation at electron polar zones, comparison with the Crab pulsar, and theoretical predictions. Gamma rays produced by electrons accelerated in the strong magnetic fields annihilate to produce electron–positron pairs, leading to a two-stream situation that results in bunching and coherent radio emission. (UK)

42413 CORRELATION OF SUBPULSE STRUCTURE IN A SEQUENCE OF PULSES FROM PULSAR PSR 1919+21. Backer, D. C. (Cornell-Sydney Univ., Puerto Rico). Nature (London); 227: 692-5(15 Aug 1970).

It is stated that previous analyses of pulsar radiation have been concerned mainly with (a) average properties such as shape, strength, and polarisation of the pulses by averaging the data with the primary period (p_1) removed, and (b) pulse energy distributions and fluctuation spectra using a sequence of total pulse energies. The former analysis gives no information as to how the average is related to the individual pulses, and the latter gives no information about processes occurring within the pulse profile. In the present communication, the results of two statistical analyses of a two-dimensional data array of pulse intensity vs pulse phase and pulse number are given for the pulsar 1919 + 21 (CP 1919). A Fourier analysis was performed on a sequence of momentary pulse energies, formed by integrating the received radiation intensity over narrow time gates, spaced by P_1 and hence corresponding to the same pulse phase for successive pulses. Repetition of the analysis for independent phases converted the two-dimensional data array to a two-dimensional spectral array of fluctuation power versus frequency and pulse phase. The second analysis converted the data array into an array of frequency of occurrence of a given intensity versus intensity and pulse phase; this is presented as a counter map of frequency of occurrence on an intensity versus pulse phase plane. The results are used to analyse the class-two process which occurs in PSR 1919 + 21, and to discuss how the average pulse is statistically constituted. The analysis indicates that the class-two period is a function of pulse within the pulse profile. (UK)

42414 SCATTERING OF THE DECAMETER RADIO EMISSION OF THE CRAB NEBULA BY THE SOLAR CORONA. Bazelyan, L. L.; Braude, S. Ya.; Men, A. V. (Inst. of Radiophysics and Electronics, Kiev). Sov. Astron. AJ (Engl. Transl.); 14: 153-62 (Jul-Aug 1970).

Translated from Astron. Zh.; 47: 188-200(Jan-Feb 1970).

The results are reported of an investigation of the 1965 and 1966 occultations of Taurus A by the solar corona at frequencies of 20, 25, 31, and 38 MHz, using two interferometers with baselines of 88 and 470 m. The decline in the integrated flux density of the source was determined over angular distances from 5 to 20 $R_\odot$. The wavelength dependence of the increase in angular size is found to differ from the λ^2 relation observed at meter wavelength. (auth)

42415 SCINTILLATION OF RADIO SOURCES OF FINITE ANGULAR SIZE. Shishov, V. I. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 148-52(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 182-7(Jan-Feb 1970).

Expressions are derived for the scintillation spectra of sources of finite angular size. The scintillation spectra of large-sized sources are shown to be produced by the medium near the Earth. The theoretical results are compared with the observational evidence for the radio source 3C 273. At 195 MHz this source has components 5'' and 0.02'' in diameter. (auth)

42416 POSSIBLE EXPLANATION OF THE OBSERVED PECULIARITIES IN THE DISTRIBUTION OF QUASISTELLAR OBJECTS WITH RESPECT TO THEIR RED SHIFTS. Karitskaya, E. A.; Komberg, B. V. (Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 33-5(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 43-5(Jan-Feb 1970).

It is shown that the large-scale distribution of quasi-stellar objects with respect to their red shifts can be explained, in general terms, by the influence of their strong emission lines on the conditions for the identification of these objects. (auth)

42417 POSSIBLE ANISOTROPY IN THE RADIOEMISSION OF CERTAIN QUASARS. Kuril'chik, V. N. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 21-4(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 27-31(Jan-Feb 1970).

On the basis of 3CR catalog quasar radio spectrum analysis, the origin of anomalously flat radio spectra is considered from the position of common values for the exponent γ, in the exponential energy spectrum of relativistic electrons radiating by the synchrotron mechanism. The flat radio spectra can be the result of distinctly anisotropic streams of relativistic electrons moving from the quasar nuclei in a fairly strong (on the order of several gauss) regular magnetic field appropriately oriented with respect to the observer. (auth)

42418 ELECTRODYNAMICS OF PULSARS. Bertotti, B. (European Space Research Inst., Frascati, Italy). Riv. Nuovo Cim.; 2: 102-18(Jan-Mar 1970).

This review is concerned with attempts to understand the complex dynamics underlying the electromagnetic emissions of pulsars. All problems associated with neutron stars are neglected. Topics covered include the oblique rotator, periodic character of the pulses, slowing-down, the emitted radiation, the oblique rotator as a particle accelerator, and the emission mechanism. (W.D.M.)

42419 POSSIBILITIES OF PULSED GAMMA EMISSION IN EXCESS OF 50 MeV FROM THE CRAB NEBULA DIRECTION. Vasseur, Jacques (CEN de Saclay, Gif-sur-Yvette, France); Paul, Jacques; Parlier, Bruno; (and others). Compt. Rend., Ser. B; 271: 61-4(6 Jul 1970). (In French).

The discovery of the NP 0532 pulsar in the radio, optical, and x-ray bands has orientated research towards the search for gamma emission in excess of 50 MeV occurring at the same frequency. The processing of data obtained from a balloon experiment in the stratosphere on the 11th of July 1969 led to the discovery of a pulsed emission, almost identical to that of the NP 0532 pulsar. A statistical study has shown the extent to which the measurements may be due only to statistical fluctuations. (tr-auth) (France)

Solar Phenomena

Refer also to abstracts 41893, 42556, 42570, 42576, 42577, 42676, and 42697.

42420 (AD-702046) RESEARCH ON THE VELOCITY FIELD OF ACTIVE SOLAR REGIONS. Final Report, May 1, 1967-October 31, 1969. Fisher, Richard R.; Zirker, Jack B. (Hawaii Univ., Honolulu. Inst. for Astronomy). Feb 1970. Contract N00014-67-A-0387-0001. 35p. CFSTI.

One of the prime objectives of the research program was to develop a new and improved method of recording the Doppler velocity field over a two-dimensional solar image. The method is basically an extension of Leighton's spectroheliographic technique but employs a closed-circuit TV system in the actual image subtraction process in order to eliminate the complex photographic subtraction employed by Leighton. The basis of the method is described. (USGRDR)

42421 (AD-702147) DYNAMICS OF THE SOLAR CHROMOSPHERE AND ERUPTIVE PHENOMENA. Final Scientific Report, July 1, 1968-June 30, 1969. Macris, Constantin J. (National Observatory, Athens (Greece). Astronomical Inst.). Nov 1969. Contract F61052-69-C-0031. 42p. (AFCRL-70-22). CFSTI.

The following topics are considered: (1) Study of the quality of the the Hα filter used for the observations and the determination of its transmission curve. (2) Photometric structure and the evolutive curves of solar flares at several intensity levels. The evolutive curves were compared with curves obtained from radio observations at several wavelengths. These flares were photographed at the Observatory of Athens using the 16-cm refractor of the triple heliograph. (3) New observational results are given concerning the fine structure and dynamic phenomena of the solar chromosphere. The research was made on high-resolution photographs of the solar chromosphere, taken with the 40-cm refractor of the National Observatory of Athens. (auth) (USGRDR)

42422 (LA-4454) VELA V AND VI SOLAR X-RAY ATLAS. I. MAY 27-SEPTEMBER 1, 1969. Blocker, N. K.; Chambers, W. H.; Fehlau, P. E.; Fuller, J. C.; Kunz, W. E.; Milkey, R. W. (Los Alamos Scientific Lab., N. Mex.). Jun 1970. Contract W-7405-eng-36. 100p. Dep. CFSTI.

Data obtained from the solar radiation monitors on the Vela V satellites are presented. Equivalent graybody flux in three bands (0.3 to 3, 1 to 8, and 1 to 16 Å) is plotted as a function of universal time, one day per page. Data from May 27 to September 1, 1969 are presented. (auth)

42423 ANALYSIS OF RADIO SCATTERING AND SPACE-PROBE OBSERVATIONS OF SMALL-SCALE STRUCTURE IN THE INTERPLANETARY MEDIUM. Cronyn, Willard M. (Univ. of Maryland, College Park). Astrophys. J.; 161: 755-63(Aug 1970).

The relationship between the power spectrum of magnetic-field or electron-density irregularities convected past a space probe and the power spectrum of radio-intensity scintillations is derived. If the spatial power spectrum of the irregularities is power law with index q, the spectrum of the temporal fluctuations seen by the space probe, as the irregularities are convected past it in the solar wind, is also power law with index $q-2$. If the irregular electron-density structure is described by the same power-law spatial spectrum with index q, the spectrum of the temporal intensity scintillations will also be power law with index $q-1$. The relationship is applied to a limited amount of scintillation and space-probe spectral data and provides the first evidence for similar small-scale spatial structure in the magnetic field and electron density. It is suggested that scintillation spectra be described by their high-frequency power-law index in addition to the usual parameters of scintillation index and second moment. (auth)

42424 OBSERVATION OF A VORTEX RING IN THE SOLAR ATMOSPHERE. Hagen, John P.; Neidig, Donald F. Jr. (Pennsylvania State University Park). Astrophys. J.; 161: 751-3 (Aug 1970).

A vortex ring, or "smoke ring," formed in the solar atmosphere above a class 1B flare was photographed in Hα light on Dec. 2, 1969. The ring persisted for less than 2 minutes, with the fast-moving material out of which it was formed being reflected back toward the photosphere. (auth)

42425 NON-LTE LINE-BLANKETED SOLAR MODEL. Athay, R. Grant (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 161: 713-35(Aug 1970).

Line-blanketing effects are evaluated for selected strong solar lines and for representative cases from the remaining lines. A composite blanketing curve representing the effect of all lines is constructed from the combined blanketing curves for the selected and representative lines. Separate composite blanketing curves are obtained for four model atmospheres with different assumed temperature distributions, T_1. The blanketing functions are used to compute blanketed model atmospheres, whose temperature distributions are T_b. A self-consistent model for which $T_b \approx T_1$ is obtained by iteration. In the self-consistent model the boundary temperature is 4330°K with estimated error limits of ±150°. It is shown that the tendency for a temperature rise at small τ_c produced by the Cayrel mechanism is strongly resisted by the blanketing mechanism and that temperatures as high as 4600° near $\tau_c = 10^{-4} - 10^{-6}$ would require substantial input of mechanical energy. (auth)

42426 ELECTRON CORRELATIONS AND SOLAR NEUTRINO COUNTS. Diesendorf, M. O. (Imperial Coll. of Science and Tech., London). Nature (London); 227: 266-7(18 Jul 1970).

Studies of the neutrino flux from the Sun could be used to test the basic hypotheses concerning its internal constitution and the nuclear fusion reactions believed to be occurring in its interior. The measurements of Davis et al. (Phys. Rev. Lett. 20: 1205 (1968)), give an upper bound on the neutrino counting rate that is approximately half of the theoretical rate calculated by Bakcall et al. (loc. cit. 20: 1209(1968)), and an order of magnitude smaller than theoretical rates obtained by other authors. Before the discrepancy between theory and experiment can be accepted as requiring a radical change in the theory of stellar structure however, it is first necessary to reduce the uncertainties and poor approximations obtained in the theory, which are concerned with equations for nuclear reaction rates, pressure and opacity, expressed as a function of density, temperature, and chemical composition. In current tables of solar opacity the contribution from the scattering of radiation by free electrons is calculated under the unjustified assumption that the plasma of the solar interior can be treated as a perfect classical gas, and hence that the scattering cross section is given simply by the classical frequency-independent Thomson cross section for independent electrons in the plasma. It is shown that corrections to this cross section due to classical and quantum electron correlations reduce the electron scattering opacity in the core of the Sun by approximately one-third, and that this leads to a significant reduction in the theoretical neutrino flux. The percentage deviations in the cross section resulting from such correlations in Bakcall's variable composition model are shown in tabular form. The domain considered extends from the center out to 0.33 $R_\odot$, and contains 0.69 $M_\odot$ and the energy generation region. The result is to reduce the effective cross section by an amount almost constant over the whole of the solar domain considered, and equal to 34.5% at the center. It can be seen from the energy transport equation that the temperature gradient in the core is reduced, and since the rates of nuclear reactions are highly sensitive to the ambient temperature, a modification to the neutrino flux is to be expected. The assumption that energy transfer in the core occurs by radiation rather than convection also becomes more plausible. An estimate of the modification to the neutrino flux follows from the work of Bakcall et al. (Astrophys. J., 156: 559(1969)), who computed the effect on the solar model of hypothetical localized deviations in opacity. If electron correlations are the only source of deviation, a 30 to 40% reduction in the theoretical neutrino counting rate is estimated, and a fair match between theory and experiment is obtained. Increases have recently been found, however, for the opacity contributions from autoionization lines, ordinary lines, and bound–free transitions, of which the last named by be important, and might more than offset the decrease in neutrino rate from electron correlations. A major uncertainty is the chemical compositions of the core. (UK)

42427 ATLAS OF EXTREME-ULTRAVIOLET SPECTROHELIOGRAMS FROM OSO-IV. Reeves, E. M.; Parkinson, W. H. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., Suppl. Ser.; 21: No. 181, 1-30(Aug 1970).

The atlas contains a collection of far-ultraviolet solar spectroheliograms obtained by the Harvard College Observatory spectrometer on the fourth Orbiting Solar Observatory launched in October 1967. An extended series of plates depicts composite spectroheliograms as a numerical matrix suitable for quantitative studies and is accompanied by pictorial representation in quasi-photographic form and in the form of contour maps. The necessary photometric conversion factors are contained on each plate to convert the numerical data into emergent solar flux and also flux received at the top of the Earth's atmosphere. Each spectroheliogram is a composite of the best data within the daylight portion of the orbits, and the series includes most of the stronger solar emission lines and continues in the wavelength region 300 1400 Å covering stages of ionization from neutral species to species ionized fifteen times. The spectroheliograms have a spatial resolution of 1 minute of arc. The operational characteristics of the instrument are discussed, together with the wavelength sensitivity, telescope slit function, spectrometer line profile, photometric calibration, and calibration changes on the ground and in orbit. (auth)

42428 ANALYSIS OF THE SOLAR WIND DATA FROM PIONEER VI. Pichler, Helmut (Univ., Vienna). Arch. Meteorol., Geophys. Bioklimatol., Ser. A; 19: 187-94(1970). (In German).

Solar wind observations that were collected by Pioneer VI during the solar rotations 1855 to 1859 are reported. The frequency distributions of the solar wind speed, the particle density, the particle flux and the density of the kinetic energy of the solar wind are represented. It can be seen that in all the four cases the distributions are not gaussian. Further, it is proved that there is no relation between the solar wind speed and the particle density, however, it could be shown that a clear exponential relation exists between particle flux and the density of kinetic energy. (auth)

42429 THEORY OF POLARIZED TYPE-III AND U-BURST EMISSIONS FROM THE SOLAR CORONA. Yip, W. K. (Univ. of Tasmania, Hobart, Australia). Planet. Space Sci.; 18: 867-85(Jun 1970).

The generation of Cherenkov plasma waves by fast electron streams in the solar corona and their subsequent transformation into electromagnetic waves are considered, taking the effect of the coronal magnetic field into account. It is shown that the observed properties of polarized type-III and U-burst emissions may be accounted for by this process. (auth) (UK)

42430 MOTION OF THE INTERPLANETARY DUST CLOUD. James, J. F.; Smeethe, M. J. (Univ. of Manchester, Eng.). Nature (London); 227: 588-9(8 Aug 1970).

Reference is made to Reay and Ring (Nature, 219: 710(1968)); Planet. Space Sci., 17: 561(1969)) who obtained values for the Doppler shift of the scattered component of the evening zodiacal light, and observations are described that extend these values to include both the evening and morning zodiacal lights. In order to lessen interference by H_β emission, the spectrum in the region around the b_1 component of the Mg II Fraunhofer line at 5183.6 Å was studied. The spectrometer and other equipment used are described; this included a solid-state photon-counting system. A typical counting rate from the zodiacal light at 30° elongation was 60/sec, and from the night sky, 5 to 10/sec. The observations were made during March and April 1969, on the morning and evening zodiacal light, the twilight sky, and on the Moon and Jupiter, the latter three sources providing a wavelength reference for calibrating the system. It was found that the redshift of the morning zodiacal light and the corresponding blue shift of the evening light increased markedly, with decreasing elongation. The magnitude of the shift was such as expected if the partial size index was <3, and it would follow that radiation pressure does not play an important part in the short-term dynamics of the dust cloud. There was no evidence for a component of the dust cloud in retrograde orbit around the Sun. The observations also suggested the possibility that the redshifts in the morning light are consistently greater in magnitude than those in the evening; in theory they should be of the same magnitude, but of opposite sign. (UK)

42431 FIZIKA KOMET. (Comet Physics). Conference on Physics of Comets, Kiev, October 1966. Konopleva, V. P. (ed.). Respublikanskii Mezhvedomstvennyi Sbornik. Seriya Astrometriya i Astrofizika. Kiev; Izdatel'stvo Naukova Dumka (1969). 224p. CONF-661072).

Separate abstracts were prepared for two of the sixteen papers presented. (W.D.M.)

For abstracts of individual papers see: 42432 and 42433.

42432 REMARKS ON SOLAR CORPUSCULAR RADIATION BASED ON SPACE DATA. Dvoryashin, A. S. (Krym Astrophysical Observatory, USSR). pp 7-39 of Fizika Komet. /Konopleva, V. P. (ed.). Kiev; Izdatel'stvo Naukova Dumka (1969). (In Russian).

From Conference on Physics of Comets, Kiev, USSR. See CONF-661072.

Data on corpuscular radiation obtained from geophysical observations and space experiments are considered. The existence of the stable four-streamer structure that causes four consequences of geomagnetic disturbances is established. Every streamer carries a magnetic field mainly of one polarity. The four-streamer model of the interplanetary magnetic field with definite boundaries that exists during some revolutions of the Sun may be constructed. (auth)

42433 SOLAR CORPUSCULAR RADIATION OBTAINED FROM THE MEASUREMENTS WITH SATELLITES AND ROCKETS. THE FOUR STREAMERS MODEL OF THE SOLAR CORONA NEAR THE MINIMUM OF ACTIVITY. Dvoryashin, A. S. (Krym Astrophysical Observatory, USSR). pp 40-53 of Fizika Komet. /Konopleva, V. P. (ed.). Kiev; Izdatel'stvo Naukova Dumka (1969). (In Russian).

From Conference on Physics of Comets, Kiev, USSR. See CONF-661072.

The four-streamer model of the solar corona was constructed for the period near the minimum of solar activity using the measurement data on the plasma and field from satellite and rocket observations. The peculiarities of the magnetic disturbances of the Earth's magnetic field may be explained by the complex structure of the coronal rays. This structure reflects the source's distribution in the field of rays. (auth)

42434 ELECTRON CONCENTRATION AND STRUCTURE OF CHROMOSPHERIC FLARES. Kurochka, L. N. (Kiev State Univ.). Sov. Astron. AJ (Engl. Transl.); 14: 89-97(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 111-21(Jan-Feb 1970).

The electron concentration in chromospheric flares was de-

termined from the half-widths and also from the numbers of the faintest resolvable lines in the Balmer series ($10^{12} \leq n_e \leq 5 \cdot 10^{13}$ cm^{-3}). It was found that the effective extent of flares is several orders of magnitude less than the observed extent and flare radiation arises in relatively thin filaments. Filaments with a high electron concentration are found primarily in the central part of a flare. The medium situated between the filaments absorbs photospheric radiation in individual lines. The electron concentration between filaments is close to chromospheric. (auth)

42435 HELIOGRAPHIC LONGITUDE DISTRIBUTION OF TYPE III RADIO BURSTS. Fomichev, V. V.; Chertok, I. M. (Inst. of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 185-6 (Jul-Aug 1970).

Translated from Astron. Zh.; 47: 226-7 (Jan-Feb 1970).

The observed heliographic longitude distribution of harmonic Type III radio bursts can be explained satisfactorily in terms of the Raman scattering mechanism for the formation of the second harmonic. (auth)

42436 CONTRIBUTION TO THE THEORY OF TYPE III SOLAR RADIO BURSTS. I. Zheleznyakov, V. V.; Zaitsev, V. V. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 14: 47-58 (Jul-Aug 1970).

Translated from Astron. Zh.; 47: 60-75 (Jan-Feb 1970).

The influence of nonlinear effects on the dynamics of the development of a two-stream instability under conditions typical of Type III sources of radio-frequency emission is investigated. The need to take quasi-linear relaxation of the distribution function of fast electrons into account is demonstrated. The time of deformation of the distribution function is at the very least not longer than the characteristic time of development of the most efficient nonlinear process due to induced scattering of beam-excited plasma waves on thermal ions of the corona. Stabilization of the two-stream instability is found to be immaterial for that reason. Light is shed on the role of collisions and the inhomogeneity of the leading edge of the stream in restoration of two-stream instability following quasi-linear relaxation. The energy associated with the plasma waves generated by the beam of fast electrons was computed, and the conditions under which transfer of plasma waves over ths spectrum by pumping, on account of induced scattering, can be ignored were determined. (auth)

42437 DETERMINATION OF THE TWO-DIMENSIONAL STRUCTURE OF THE NOISE STORM OF MAY 20, 1966 FROM DATA OF ECLIPSE OBSERVATIONS AT FOUR STATIONS. Gnezdilov, A. A. (Inst. of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 59-63 (Jul-Aug 1970).

Translated from Astron. Zh.; 47: 76-81 (Jan-Feb 1970).

Results of an analysis of observations of the solar eclipse of May 20, 1966 made at four stations at frequencies close to 200 MHz are presented. The refraction of the radio emission in the solar corona is taken into account in the analysis; a justification is given for the assumption about the radial position of the source of the noise storm above sunspot group No. 60, observed on the same day on the northeast edge of the solar disk. It follows from the analysis that the source of the noise storm consisted of a compact source of enhanced radio emission with an apparent size of less than 1′; a region of continuous background emission of the noise storm with a size of 3.3′ × 2.1′; and a region where type I bursts are generated, with a size of 1.5′ × 2′. The centers of the emission components were located at heights of 0.21, 0.27, and 0.32 $R_\odot$, respectively, above the surface of the photosphere. (auth)

42438 STRUCTURE OF THE MAGNETIC FIELD IN A SUNSPOT WITH A PHOTOSPHERIC LIGHT-BRIDGE AT TWO LEVELS IN THE SOLAR ATMOSPHERE. Abdusamatov, Kh. I. (Samarkand Univ., USSR. Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.); 14: 64-71 (Jul-Aug 1970).

Translated from Astron. Zh.; 47: 82-90 (Jan-Feb 1970).

Simultaneous photographic observations in two lines of the solar spectrum (Hα and λ 6302.499 Å) are used to study the space structure of the magnetic field in a following sunspot having a photospheric light bridge. The spot field penetrates into the chromosphere with weakened intensity ($H_{chr} \approx 0.5\ H_{ph}$); the vertical gradient $dH/dh \approx 0.5$ Oe/km. No appreciable vertical magnetic-field gradient has been detected above the observed light bridge. It is concluded that the magnetic-field strength in the observed type II light bridge is the same as that in faculae. The presence of the light bridge leads to a breakup of the spot magnetic field in space, with the bridge separating magnetic regions of the same polarity. The light bridges are considered to form because of the breakup of sunspot magnetic fields, a process beginning in the subphotospheric layer and culminating at the photospheric level. The conclusion is reached that light bridges are an inherent part of the structure of a sunspot umbra, not simply an overlying formation. (auth)

42439 ENERGY BALANCE IN SPICULES. Nguyen-Ngan (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 72-7 (Jul-Aug 1970).

Translated from Astron. Zh.; 47: 91-7 (Jan-Feb 1970).

The problem of the energy balance in spicules is discussed. The energy loss of the gas in exciting transitions in H, He, and Ca^+ atoms, in ionizing hydrogen, and in free–free emission is calculated for $n_e = 3 \times 10^{11}$ cm^{-3} and 7500 < T < 20,000°K. The energy loss is about 10^{-1} erg cm^{-3} sec^{-1}. If there were no outside energy source the spicules would cool in < 30 sec. Various possible energy sources that may compensate for the losses are considered. Coronal radiation and heat conductivity are incapable of furnishing the energy needed to maintain the temperature of a spicule throughout its lifetime. Apparently the only possible source is the energy flux of various waves emerging from below. According to Pikel'ner's hypothesis, waves will move along a spicule as in a waveguide, suffering no refraction or reflection. Their energy flux will diminish only through dissipation. A rough estimate indicates that such waves will provide enough energy to compensate for the losses. (auth)

42440 FORMATION MECHANISM OF ACTIVE REGIONS. Ponomarenko, Yu. B. (Inst. of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 78-82 (Jul-Aug 1970).

Translated from Astron. Zh.; 47: 98-102 (Jan-Feb 1970).

A mechanism is discussed wherein the magnetic field of an active region is formed when the general toroidal field of the Sun emerges at the surface. It is assumed that the emergence of the toroidal field is accomplished through the motion of giant granules—convection cells with a size of ≈ 180,000 km and a lifetime of about one month. The rate of motion at the surface is ≈ 80 m/sec. Gas rises at the center of the giant granules and sinks along the periphery. The asymmetry of sunspots and the inclination of the axes of active regions relative to the east–west line are ascribed to the influence of Coriolis forces on the motion in the giant granules. (auth)

42441 MECHANISM FOR THE FORMATION OF THE CN LINES IN THE SOLAR PHOTOSPHERE. Khlystov, A. I. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 83-8 (Jul-Aug 1970).

Translated from Astron. Zh.; 47: 103-10 (Jan-Feb 1970).

It is established from a discussion of elementary processes that the formation mechanism of the lines in the violet band system of the CN molecule in the solar photosphere is completely incoherent scattering in the presence of an interaction effect between the electronic and rotational levels by means of radiation, and an interaction effect between the vibrational levels by means of radiation and vibrational transitions in the excited electronic state due to collisions with hydrogen atoms. (auth)

42442 SOLAR RADIATION AND SOLAR ACTIVITY. Kondratev, K. Ya.; Nikolskii, G. A. (Leningrad State Univ.). Quart. J. Roy. Meteorol. Soc.; 96: 509-22 (Jul 1970).

Using high-altitude balloon soundings (1961 to 1968) and other data, it is shown that the most reliable maximum value of the solar constant is at present 1.94 cal cm^{-2} min^{-1}, to an accuracy of 1%. This value is observed with Wolf numbers between 80 and 100, below or above which the solar constant decreases. The maximum decrease does not exceed 2 to 2.5%. The observations reveal the influence of nuclear explosions and volcanic eruptions which caused an anomalous turbidity of the upper atmospheric layers. These anomalies have been studied. The above conclusions require further confirmation using direct long-term measurements of the solar constant outside the atmosphere. (auth) (UK)

42443 SOLAR RADIATION. Peyturaux, M. (Centre National de la Recherche Scientifique, Paris). Rev. Gen. Therm.; 9: 661-72 (May 1970). (In French).

The history of solar energy is described from its production in the heart of the Sun from the conversion of hydrogen into helium, to its diffusion in the Universe through the superficial layers (photosphere, chromosphere, and corona). It is shown how the basic phenomena change into a series of various radiations. (auth) (France)

42444 CONCERNING THERMONUCLEAR REACTIONS IN THE INTERIOR OF THE SUN AND SOLAR NEUTRINOS. Kocharov, G. E.; Starbunov, Yu. N. (Ioffe Inst. of Physics and Tech., Moscow). JETP Lett. (USSR) (Engl. Transl.); 11: 81-3 (20 Jan 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 132-5 (20 Jan 1970).

Negative results of attempts to register solar neutrinos have made it necessary to review more critically the theory of stellar structure and evolution. At the 11th Int. Conf. on Cosmic Rays, the authors proposed and analyzed a new possibility of decreasing the flux of high-energy solar neutrinos. The analysis was based on the assumption that the Sun contains a relatively large amount of ^{3}He. This assumption is discussed in some detail. (W.D.M.)

42445 DIFFERENTIAL ROTATION CAUSED BY ANISOTROPIC TURBULENT VISCOSITY. Koehler, H. (Univ., Goettingen, Ger.). Solar Phys.; 13: 3-18(Jul 1970).

The law of rotation as well as the corresponding meridional circulations in the hydrogen convection zone (HCZ) were investigated by solving numerically the time independent Navier–Stokes equations. The HCZ is assumed to be a spherical layer of fluid with constant density and viscosity. It is assumed further that the viscosity is caused by unisotropic turbulent motions. The results show differential rotation together with circulations. The detailed behavior depends on a parameter s characterizing the nonisotropic friction and on the kinematic viscosity v. If the friction is larger in radial direction than in lateral directions ($0 \leq s < 1$) the poles rotate faster than the equator and the circulation rises at the equator and falls at the poles; if friction is smaller in radial direction ($s < 1$) the equator rotates faster and the sense of the circulation is reversed. The differential rotation observed at the solar surface is obtained for the value $s = 1.2$. For small values of v the angular velocity is constant on cylindrical surfaces, for large values of v it is constant on spherical surfaces. The solar law of rotation turns out to be very close to the first case. (auth)

42446 SOLAR ABUNDANCE OF NICKEL FROM PHOTOSPHERIC [Ni II] LINES. Grevesse, N. (Univ., Liege); Swings, J. P. Solar Phys.; 13: 19-24(Jul 1970).

The detailed study of the possible presence of four [Ni II] lines in solar absorption leads to an abundance $A_{Ni} = \log N_{Ni} = 6.30 \pm 0.30$ (in the usual scale where $\log N_H = 12.00$), in agreement with the coronal and meteoritic values. (auth)

42447 SEARCH FOR RHENIUM LINES IN THE FRAUNHOFER SPECTRUM. Swensson, J. W. (Univ., Liege. Univ., Lund, Sweden). Solar Phys.; 13: 25-32(Jul 1970).

On the basis of a series of low-noise, high-resolution photometric tracings of the Fraunhofer spectrum a search was made in the Sun for the ultimate lines of neutral rhenium. The records examined showed no convincing evidence for the presence of solar Re I lines. For the rhenium content of the photosphere the present investigation gives an upper limit of approximately $\log N_{Re} = -0.3$, on the standard scale where $\log N_H = 12.00$. (auth)

42448 TEMPERATURE DIFFERENCE BETWEEN THE EQUATOR AND THE POLES OF THE SUN. Caccin, B. (Capodimonte Observatory, Naples); Falciani, R.; Moschi, G.; Rigutti, M. Solar Phys.; 13: 33-41(Jul 1970).

A possible variation of the photospheric temperature from the equator to the poles was investigated through the observation of the variation of the equivalent width of selected spectral lines sensitive to temperature variations. The present observations, made during the summer of 1964, show that the temperature variations, if any, must roughly be smaller than 1% of the limit temperature. A possible dependence of the temperature variations on the phase of the solar cycle was also examined and it seems that no definite statement may be made at present. There are, however, some reasonable expectations that no temperature difference between poles and equator may exist at any time. (auth)

42449 POLAR MAGNETIC FIELDS OF JULY AND AUGUST 1968. Stenflo, Jan Olof (Astronomical Observatory, Lund, Sweden). Solar Phys.; 13: 42-56(Jul 1970).

Observations of the polar magnetic fields were made during the period July 3 to August 23, 1968, with the Mt. Wilson magnetograph. The scanning aperture was 5 in. by 5 in. The magnetic field was found to be of S polarity near the heliographic north pole and of N polarity near the south pole. At lower latitudes the polarity was the opposite. The polarity reversal occurred at a latitude of about +70° in the north and –35° in the south hemisphere. This coincides with the position of the polar prominence zones at that time. The observations indicate that the average field strength at the south pole was well above 5 G. Synoptic charts of the magnetic fields have been plotted in a polar coordinate system for two consecutive solar rotations. (auth)

42450 LIFETIME OF THE Hα CHROMOSPHERIC NETWORK. Rogers, Ernest H. (Aerospace Corp., El. Segundo, Calif.). Solar Phys.; 13: 57-77(Jul 1970).

Time-lapse photographs of the Hα chromospheric network were taken at 3-sec intervals with a ¼-Å filter centered at Hα + 0.65 Å, where the network appears as a system of dark mottles. A nearly continuous sequence of 62 hr duration was made possible by summertime operation of the telescope at Thule Air Base, Greenland, 10° above the Arctic Circle. A quiet region was followed across the center of the disc. The life history of the network, as determined by measurement of the cross-correlation of selected photographs taken at intervals ranging between 3 sec and 29 hr, shows a rather complicated behavior. Initially the correlation falls off quite rapidly, dropping from 0.97 at 3 sec to 0.60 at about 7 min. Thereafter, the decline becomes increasingly more gradual, reaching a value of 0.24 at 4 hr. From this point the correlation falls off quite slowly. A least-squares fit to that portion of the cross-correlation curve for time differences greater than 4 hr yields a mean (1/e) life of 25.0 ± 1.6 hr and a value for twice the half-life of 38.8 ± 4.0 hr. This rate of decline is believed to be characteristic of the lifetime of the chromospheric network. The rapid initial loss of correlation appears to be due to a redistribution of the features, seen in the red wing of the Hα line, along the network. (auth)

42451 INTERFERENCE FILTER FOR OBSERVING THE PHOTOSPHERIC NETWORK. Chapman, Gary A. (Univ. of Hawaii, Honolulu). Solar Phys.; 13: 78-84(Jul 1970).

Photographs of the Sun, recently obtained with a violet interference filter ($\lambda \simeq 3840$ Å), show the photospheric network (or photospheric faculae) with a contrast of typically 20% across the entire solar disk. Since this network is cospatial with photospheric magnetic fields, one is able to determine the positions (not polarity) of these magnetic fields with fairly modest equipment. Furthermore, numerous dark structures and a faint dark network can be seen through the violet filter. (auth)

42452 MAGNETIC FIELD IN PORES. Simon, G. W. (Air Force Cambridge Research Labs., Sunspot, N. Mex.); Weiss, N. O. Solar Phys.; 13: 85-103(Jul 1970).

The magnetic field in an axisymmetric pore is current-free and can be represented by a flux tube with a magnetic potential of the form $AJ_0(kr)e^{-kz}$. For a given magnetic flux, the field in this pore model is uniquely defined if the magnetic pressure balances the gas pressure at two levels. For models with fluxes of 0.5 to 3.0×10^{20} Mx the surface radius varies from 1100 to 2700 km (diameters of 3 to 8 arc-sec) and the Wilson depression is estimated at 200 km. As the flux increases, the field becomes nearly horizontal at the edge of the pore and eventually a penumbra is formed. The distinction between pores and sunspots is investigated; the critical flux is about 10^{20} Mx, corresponding to a radius of 1500 km. (auth)

42453 COMPLETE PHOTOELECTRIC SUNSPOT SPECTRUM: AN ATLAS FROM 3900 TO 8000 A. Woehl, H.; Wittmann, A.; Schroeter, E. H. (Univ., Goettingen, Ger.). Solar Phys.; 13: 104-17(Jul 1970).

Complete photoelectric spectra of the photosphere as well as of both umbra and penumbra of a typical sunspot, ranging from 3900 to 8000 Å, were obtained at the Locarno Observatory. An automatic scanning device, a high-precision electronic divider, and an on-line Oscillomink penless recorder enabled elimination of the noise produced by image distortion and scanning the entire visible spectrum within just 5 h. The recordings had a linear dispersion of about 50 mm/Å and a spectral resolution of 40 mÅ or better. Simultaneously with these observations the momentary continuous spot intensity and its fast variation with time due to seeing variations were recorded with a frequency resolution up to 100 Hz. In order to provide as much data as possible for the correction of the umbral spectrum for parasitic light, the limb profile and the aureola intensity at several wavelengths were also measured. At present, the recordings are being processed and combined into an atlas, which is to be made available in either numerical or graphical form. As a first result, the corrected continuous sunspot intensities are compared with those of other authors and derive standard reference data on the radiation of both umbra and penumbra of a typical sunspot. Finally, a comparison is made between some radiative properties of sunspots and late-type stellar atmospheres. (auth)

42454 PHOTOELECTRIC POLARIMETRY OF A DARK UNIPOLAR SUNSPOT. Deubner, F.-L.; Goehring, R. (Fraunhofer Inst., Freiburg i. B.). Solar Phys.; 13: 118-25 (Jul 1970).

Photoelectric polarization measurements in a stable sunspot (type H) with a particularly dark umbra carried out with the Capri magnetograph were evaluated in terms of Unno's (1956) theory to give the value and direction of the magnetic field vector. A linear increase of the inclination angle with distance from the spot

center up to $r \approx 1.2\ R_\odot$ resulted, as originally found by Hale and Nicholson (1938) with a different procedure. The field strength decreased from the maximum value (about 3300 Γ) to about 15% at the penumbral border, still continuously decreasing outside the spot. The projected field direction deviated considerably from the radial symmetry in several parts of the spot region, but it was in good agreement with that of the overlaying chromospheric structures. (auth)

42455 RATIO BETWEEN THE MECHANICAL FLUXES IN- AND OUTSIDE THE SOLAR CHROMOSPHERIC MOTTLES. de Jager, C. (Astronomical Inst., Utrecht); de Loore, C. Solar Phys.; 13: 126-30(Jul 1970).

Available information about the relative areas on the "quiet" and "active" parts of the Sun covered with magnetic elements, together with theoretical results on the relation between the photospheric mechanical flux and the consequent coronal electron density, allows one to conclude that the mechanical flux generated in the photospheric magnetic elements is about seven times as large as the flux generated in nonmagnetic regions. (auth)

42456 MAGNETIC FIELDS AND THE SOLAR CORONA. III. THE OBSERVED CONNECTION BETWEEN MAGNETIC FIELDS AND THE DENSITY STRUCTURE OF THE CORONA. Newkirk, Gordon Jr.; Altschuler, Martin D. (High Altitude Observatory, Boulder, Colo.). Solar Phys.; 13: 131-52(Jul 1970).

Coronal magnetic fields calculated by the methods developed in Paper I (Altschuler and Newkirk, 1969) and the empirical description of the solar corona of November 1966 derived in Paper II (Newkirk et al., 1970) are combined in order to investigate what relation exists between the magnetic fields and the density structure of the corona. To facilitate the comparison of magnetic fields with gross coronal features, magnetic configurations are divided into three classifications—diverging fields (DF), low magnetic arcades (LMA), and high magnetic arcades (HMA). It is found that DF's occur above active plages and correlate primarily with low enhancements in the corona. Magnetic arcades (MA) appear to correlate with coronal streamers, implying that streamers form above the neutral line between extended regions in the photosphere of opposite magnetic polarity. Comparison of the density structure of the corona—as evidenced by rays, arches, and plumes—with the shape of the calculated magnetic field lines shows very satisfactory agreement. This agreement indicates that the potential magnetic field model is reasonably valid in the lower corona ($r < 2.5$ R) and that the density structure of the lower corona correlates with magnetic tubes containing varying amounts of coronal plasma. Density enhancements in the lower corona are investigated with the conclusion that the presence of high intensity magnetic fields in the photosphere implies elevated density in the corona. The geometry of the field determines the morphological form taken by the density enhancement. (auth)

42457 SOLAR CORONAL STREAMERS. II. EVOLUTION OF DISCRETE FEATURES FROM THE SUN TO 1 AU. Bohlin, J. David (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys.; 13: 153-75(Jul 1970).

A unique combination of photographic and K-coronameter data was used to study the structure and evolution of two known coronal streamers. In addition, two other K-coronameter enhancements were studied as representing ideal second examples of the known streamers. As a general rule the observations indicate that these features were directed coronal manifestations of photospheric bipolar magnetic regions (BMR) and were of two basic types: active region, by which is meant a coronal streamer which develops radially over a low-latitude active region; and helmet which denotes a streamer whose structure and development appear to be a consequence of a long-lived complex of activity, composed of both trailing magnetic fields and a parent center of disk activity. The similarity of growth rates during the first solar rotation of life led to derivation of a total streamer density of 4 to 5×10^3 cm^{-3} at $r = 1.125\ R_\odot$. This density may represent a characteristic maximum density at the base of streamers. The intensity gradient of the inner ($r \leq 1.5\ R_\odot$) corona was used to establish a qualitative evolutionary model of streamers which synthesize the observations. Briefly, streamers initially develop over active regions; the streamer growth rate may be as rapid as the disk activity, or at worst lags flare activity by $\leq \frac{1}{2}$ solar rotation. The streamer can be the cause of interplanetary and geomagnetic effects at 1 AU within a solar rotation after birth. Thereafter the streamer follows an evolution dictated by the underlying solar magnetic fields. In any case the lowest level of the coronal enhancement has a lifetime not exceeding that of the solar disk activity. (auth)

42458 CORONAL STREAMERS. III. ENERGY TRANSPORT IN STREAMER AND INTERSTREAMER REGIONS. Pneuman, G. W.; Kopp, Roger A. (High Altitude Observatory, Boulder, Colo.). Solar Phys.; 13: 176-93(Jul 1970).

The geometrical and dynamical structure of a corona consisting of streamer and interstreamer regions is examined. The present paper is an extension of previous works of this series in that energy transport processes are included in the theoretical framework of the model. Under specified conditions at some reference level above the coronal base, the structure at larger distances is determined by simultaneous integration of the continuity, momentum, and energy equations for each region subject to the condition for a lateral balance of magnetic and gas pressure at all levels. Outward thermal conduction and convection by the solar wind are assumed to be the processes contributing to the energy balance of each region, the magnetic field effectively thermally insulating one region from the other. Numerical results are presented for situations representative of the solar corona. Regions occupied by streamers are found to have higher densities than their surroundings at all distances from the Sun. For a given density at the coronal base, the density at the orbit of Earth is lower in both the streamer and interstreamer region than that predicted for radial flow. The density enhancement increases outward to a maximum value at a distance of several solar radii. In addition, beyond a distance of a few radii streamers are characterized by higher expansion velocities and lower temperatures than their immediate surroundings. Similar to the case of radial flow, supersonic solutions exist only for base densities below a certain value, which depends upon the specified base temperature and magnetic field distribution. The general features illustrated by these models are expected to persist in the advent of more sophisticated multiregion models. (auth)

42459 SOLAR LIMB BRIGHTENING AT 3.1 cm. Felli, M.; Tofani, G. (Osservatorio Astrofisico, Arcetri, Italy). Solar Phys.; 13: 194-7(Jul 1970).

The existence of limb brightening at the equator of the quiet Sun at 3.1 cm is derived from a statistical analysis of scans of the solar disk taken during 1968. A ratio of 0.7% is found between the flux emitted by the equatorial limb enhancements and that of a disk of uniform brightness temperature. (auth)

42460 SOLAR SOFT X-RAY FLARE SPECTRA FROM OSO-4. Meekins, J. F.; Doschek, G. A.; Friedman, H.; Chubb, T. A.; Kreplin, R. W. (Naval Research Lab., Washington, D. C.). Solar Phys.; 13: 198-212(Jul 1970).

Solar-flare spectral data, covering the wavelength range 0.7 to 8.5 Å, were derived from the NRL Bragg crystal spectrometers aboard OSO-4. A detailed analysis of the soft x-ray spectra for the 3b flare of November 16, 1967 (2140 UT) is presented, and it is found that electron temperatures derived from continua and emission lines are compatible with a two or more component plasma, differing in temperature by 6 to 10×10^6°K. (auth)

42461 RECOMBINATION EDGES OBSERVED IN SOLAR SOFT X-RAY FLARE SPECTRA. Meekins, J. F.; Doschek, G. A. (Naval Research Lab., Washington, D. C.). Solar Phys.; 13: 213-19(Jul 1970).

Edges in the solar soft x-ray flare continuum were observed with the NRL Bragg crystal spectrometer aboard OSO-4. The edges near 2.06, 2.8, and 4.46 Å are interpreted to be due to an innershell dielectronic recombination process, details of which are presented. Two other edges, 3.59 and 3.31 Å, are interpreted to be due to recombination of the bare sulfur ion and innershell transitions of calcium. (auth)

42462 HELIUM-LIKE CALCIUM, SILICON, AND SULFUR LINES DURING THE DECAY OF A LARGE FLARE. Doschek, G. A.; Meekins, J. F. (Naval Research Lab., Washington, D. C.). Solar Phys.; 13: 220-5(Jul 1970).

Helium-like resonance, intercombination, and forbidden transitions of Ca, Si, and S were observed during the 3b solar flare of November 16, 1967, by means of the NRL Bragg crystal spectrometers aboard OSO-4. During the decay of this flare, the forbidden lines became enhanced relative to the intercombination and resonance lines. Comparisons of the observed line ratios are made with theory and mechanisms are proposed to explain the observations. (auth)

42463 SYMPATHETIC RADIOBURSTS AT mm-WAVELENGTHS. Feix, G. (Univ., Bochum, Ger.). Solar Phys.; 13: 227-31(Jul 1970).

Correlated microwave bursts between adjacent active regions were observed. An example of a "sub-burst" is presented with an interaction velocity of the order of 900 km/sec. The equivalent temperature observed rose from 7600 to 40,000°K. (auth)

42464 INTERPLANETARY SHOCK OBSERVATIONS BY MARINER 5 AND EXPLORER 34. Lazarus, A. Z. (Massachusetts

Inst. of Tech., Cambridge); Ogilvie, K. W.; Burlaga, L. F. Solar Phys.; 13: 232-9(Jul 1970).

The solar-wind flow behind shock fronts on June 25–26 and August 11, 1967 was studied using data from two spacecrafts. For the last event the spacecrafts were separated by 0.1 AU. In both cases there is a high degree of correlation between plasma parameters observed from the two spacecrafts indicating that the features retain their identity over radial distances of at least 0.1 AU. (auth)

42465 TORQUE ON THE INTERPLANETARY PLASMA DUE TO ITS ANISOTROPY. Weber, E. J. (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys.; 13: 240-2(Jul 1970).

Due to a partial conservation of the first adiabatic invariant, the interplanetary gas exhibits an anisotropy in its temperature and thus in its pressure near 1 AU, with $p_{\parallel}/p_{\perp} \simeq 2$ being a typical observed value (Hundhausen, 1968). It is shown that, based on a simple assumption of the variation of this anisotropy with radius, the resulting torque on the plasma will not produce a large change in the angular momentum loss of the Sun, but will increase the angular velocity of the solar wind at 1 AU by a factor of 3. (auth)

42466 MEASUREMENT OF SOLAR IMAGE MOTION AND BLURRING. Brandt, P. N. (Fraunhofer Inst., Freiburg i. B.). Solar Phys.; 13: 243-6(Jul 1970).

An investigation being carried out at the Fraunhofer Institut is described; it has two aims: to establish a simple method for the quantitative measurement of solar-seeing effects and to obtain information of their dependence on telescopic aperture. (auth)

42467 SHOCK WAVES IN THE SOLAR WIND. Hundhausen, A. J. (Los Alamos Scientific Lab., N. Mex.). pp 79-81 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

The relation of shock-associated geomagnetic activity to solar activity was studied by stationary and satellite observations. The directly measured propagation speed of interplanetary shocks imply transit times from their assumed solar origin to 1 AU, which are longer than those often inferred from solar-flare–sudden commencement correlation studies. These observations showed that the typical interplanetary shock is of intermediate strength, moving at 100 to 200 km/sec^{-1} through the plasma or at ~500 km sec^{-1} relative to a stationary observer. A shock observed by the Vela 4B satellite on June 5, 1967 is shown. (J.C.W.)

42468 HYDROMAGNETIC OBSERVATIONS IN THE SOLAR WIND. Ogilvie, K. W.; Burlaga, L. F. (Goddard Space Flight Center, Greenbelt, Md.). pp 82-94 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Approximately 3000 hours of satellite observations were interpreted with reference to a hydromagnetic fluid model of the solar wind. The model shows shocks, heating due to waves, discontinuities, and that the solar wind has a variable chemical constitution. (J.C.W.)

Galaxies

Refer also to abstracts 42349 and 42541.

42469 (BNWL-1419) PHOTOMETRIC MAP OF THE MILKY WAY. Smith, L. L.; Roach, F. E.; Owen, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 32p. Dep. CFSTI.

Tables of digitized absolute values of brightness of the Milky Way in one-degree intervals are given. The tables are useful in studies of the zodiacal light, the night airglow, the diffuse galactic light, and the cosmic light. (W.D.M.)

42470 (CSIRO-Trans-10124) SPIRAL ARMS OF GALAXIES ARE THE REGION OF SOLID-BODY ROTATION. Vorontsov-Vel'yaminov, B. A. Translated by M. A. Hintze (Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia), from Astron. Tsirk.; No. 495, 6-7(Feb 1969). 3p. Dep. CFSTI (U. S. Sales Only).

Evidence for the confirmation of solid-body rotation of spiral arms of galaxies is presented. Spiral structure is considered independent of the direction of rotation. (Australia)

42471 MEAN VELOCITIES OF BINARIES IN THE PERSEUS ARM. Abt, Helmut A.; Jennings, Mark; Lee, Paul D.; Villere, Karen R. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J.; 161: 477-84(Aug 1970).

Orbital elements are given for eleven faint binaries in the Perseus arm near $l^{II} \sim 100°$. The mean gamma velocity is marginally larger (4.6 ± 2.2 km sec^{-1}) than for twenty-six constant-velocity stars in the same region. It is concluded that not only is the mean radial velocity of sing e stars similar to that of neutral hydrogen gas in their vicinity, but the velocities of spectroscopic binaries are also roughly similar if those velocities are derived from measures of absorption-line wings. It is still possible that measurements of line cores for closly spaced binaries may lead to velocities that are systematically too large. (auth)

42472 TRANSPORT OF RESONANCE RADIATION IN OPTICALLY THICK MEDIA. Doschek, G. A.; Donahue, T. M. (Univ. of Pittsburgh). Astrophys. J.; 161: 737-50(Aug 1970).

The mathematical assumption of complete frequency redistribution (CFR) is investigated for the problem of the transport of resonance radiation through gaseous media of large optical thicknesses. The investigation is initiated by solving the CFR integral equation of radiative transfer in a plane-parallel layer of gas. A steady-state excited-atom density is maintained by plane-wave white-light radiation produced by a source external to the medium. Computer solutions of the CFR transfer equation are obtained for various values of the natural damping coefficient and a range of total optical thicknesses. The CFR source functions for large total optical thicknesses are then used as trial solutions in the exact integral equation for the problem. Only a first iteration is performed. The resultant intensity profiles for various values of the damping coefficient are compared with CFR profiles calculated from the CFR source functions. The orders of magnitude of the total optical thicknesses and damping coefficients used in the numerical computations approximate the values that are realized in planetary nebulae. The non-CFR intensity profiles calculated by the method described above deviate from the CFR profiles in the manner predicted by qualitative argument. (auth)

42473 BLACK HOLES IN ELLIPTICAL GALAXIES. Wolfe, A. M.; Burbidge, G. R. (Univ. of California, San Diego). Astrophys. J.; 161: 419-35(Aug 1970).

Arguments are given that suggest mass may be present in elliptical galaxies in the form of objects that lie within their Schwarzschild radii—black holes. The observed distribution of light and velocity dispersion of stars in the nuclear regions of bright ellipticals are then used to set limits to the amount of mass that can be present in this form. It is shown that, in general, the mass of a central black hole cannot exceed about 10^{10} $M_{\odot}$, but that a much greater mass could be present in the form of many black holes with masses $\leq 10^{3}$ $M_{\odot}$, in an extended distribution. To explain the high mass-to-light ratios and the observed run of surface brightness found in some ellipticals, the orbits of these subholes and the orbits of the visible stars must be mixed by encounterless relaxation. The rate at which a central black hole accelerates the evolution of a high-density stellar nucleus is calculated, and numerical results are given in a table. The form of the light distribution in the central few parsecs, if a massive black hole is present, is calculated. Only when a resolution $\leq 0.1''$ is achieved for ellipticals in the Virgo cluster can direct tests of the presence of central black holes be made by observing the light distribution. Finally, a brief discussion is given of possible ways in which black holes may occur in ellipticals. (auth)

42474 GENERALIZED THERMAL STABILITY AND ITS APPLICATION TO THE INTERSTELLAR GAS. Hunter, James H. Jr. (Yale Univ., New Haven). Astophys. J.; 161: 451-5 (Aug 1970).

In the limit of short-wavelength perturbations, Field's criteria for thermal stability are shown to be generalizable to the case of an arbitrary, perfect-gas flow. It is demonstrated that flows in the interstellar medium would be expected to be thermally unstable. (auth)

42475 INTERMEDIATE BANDPASS PHOTOMETRY OF GALAXIES AND GLOBULAR CLUSTERS. Neff, J. S. (Univ. of Iowa, Iowa City). Mon. Notic. Roy. Astron. Soc.; 149: 45-50 (1970).

Measurements with an intermediate bandpass photometric system were made for globular clusters and galaxies. The photometric data indicate that the weak-line globular clusters show an ultraviolet excess with respect to the strong-line clusters if a normal reddening law is assumed. The photometric data are consistent with Morgan's (1958, 1959, and 1962) classifications of the galaxies with the exception of the K-type galaxies, which show a range of near ultraviolet colour. A possible explanation of this result is that the K-type galaxies differ in the spectral type of the turnoff from the main sequence and in the relative population of the giant branch. (auth) (UK)

42476 GALACTIC COMPONENT OF THE DIFFUSE X-RAY BACKGROUND. Wickramasinghe, N. C. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Nature (London); 227: 265-6 (18 Jul 1970).

An increase of intensity of the cosmic x-ray background was detected in directions close to the galactic plane, indicating the possible existence of a diffuse galactic x-ray component, and the similarity of this galactic component, in both intensity and spectrum, to the general isotropic background suggests a possible causal connection. It is argued that interstellar dust near the galactic plane would scatter the isotropic background so as to produce the observed effects. The existence of a diffuse background of optical radiation close to the galactic plane has been known for many years and is usually attributed to scattering of starlight by interstellar grains; the same grains could also scatter x-rays from a cosmic background as well as from discrete sources. Scattering cross sections for x-rays are calculated. An infinite plane parallel slab model of the Galaxy is assumed, with the Sun situated in the midplane. The model predicts that the angular spread of the diffuse galactic x-ray background decreases with increasing photon energy. (UK)

42477 CONTINUUM OF M31 IN THE NUCLEAR BULGE. Cohen, Judith G. (California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac.; 82: 760-2(Jun 1970).

Sandege, et al. (1969) confirmed and extended the color aperture relation for M31 over the region within 1′ from the nucleus first reported by de Vaucouleurs and Tifft (1961). In view of the importance of the spectral energy distribution of M31 in determining the K correction, and also the possible variation of stellar content with distance from the nucleus, these measurements were extended to larger apertures. (W.D.M.)

42478 A NOTE ON STARS WITH MOTIONS OF MORE THAN 100 KM/SEC PERPENDICULAR TO THE GALACTIC PLANE AND GALACTIC MASS MODELS. Innanen, K. A. (York Univ., Toronto). Publ. Astron. Soc. Pac.; 82: 753-6(Jun 1970).

The total energies of the stars in Eggen's (1969) list of stars with high velocities perpendicular to the galactic plane were evaluated in three galactic mass models. A larger sample of the subdwarfs and the short-period Cepheids, with high velocities perpendicular to the galactic plane, could provide data to test the bounds of their absolute luminosities and provide information to determine the Galaxy's size and the local galactic gravitational potential providing the stars are not escaping from, or passing through, the Galaxy. (auth)

42479 GALAXIES IN THE DIRECTION OF TON 256 AND B 264. Bahcall, John N.; Bahcall, Neta A. (Inst. for Advanced Study, Princeton, N. J.). Publ. Astron. Soc. Pac.; 82: 721-9 (Jun 1970).

Evidence is presented which suggests that the QSO Ton 256 could be in a cluster of galaxies with the same redshift as the QSO. In order to facilitate redshift determinations, accurate positions, magnitude estimates, and a finding chart are given for the brightest galaxies that are the most likely candidates for membership in a cluster containing Ton 256. Similar measurements are provided for the galaxies in the cluster of galaxies containing the QSO B 264. (auth)

42480 INFRARED BACKGROUND FROM SEYFERT GALAXIES. Setti, G. (Univ., Bologna); Woltjer, L. Nature (London); 227: 586-7(8 Aug 1970).

Reference is made to Kleinmann and Low (Astrophys. J. Lett. 159: L 165 and 173 (1970)) who reported measurements of the infrared spectrum of the Seyfert galaxy NGC 1068, and it is suggested that, if NGC 1068 is not an anomalous object, the Seyfert galaxies may be important contributors to the infrared background in the submillimeter region, provided that cosmological evolutionary effects of the type discussed for radio sources and quasi-stellar sources are present. This is discussed in the light of recent measurements of the far-infrared background. As a larger percentage of the radiation flux would be contributed from objects with greater redshifts ($Z \propto 2.5$), most of the energy would fall in the submillimeter region, with a peak intensity somewhere in the interval 350 to 1,050 μm. These findings are compared with available observations in the far infrared, and excellent agreement is found, although several difficulties arise. It is implied that rather low-luminosity galaxies are involved. Also, important constraints on the cosmological evolution of the Seyfert galaxies may arise from their contribution to the radio and x-ray background. If an apparently strong evolutionary effect is present, only several percent of the Seyferts can emit at the level of NGC 1068 at low frequencies, and most should have a radio emission of the order of ten times smaller, similar to the normal spirals. This is not in conflict with knowledge of the radio luminosity function for Seyfert galaxies. A second limit might come from x-ray observations, although no Seyfert galaxy has been detected as an x-ray source. The possible far-infrared contribution from QSOs is also considered. (UK)

42481 SMALL DUST GRAINS AND THE HEATING OF H I CLOUDS. Wickramasinghe, N. C. (Cambridge Univ., Eng.). Nature (London); 227: 587-8(8 Aug 1970).

It is stated that radio observations of the 21-cm line of neutral H have indicated that the mean kinetic temperature of interstellar clouds is ~100°K, and temperatures close to this would seem valid for ~75% of the mass of interstellar material within the clouds. The maintenance of such temperatures, however, poses a problem of the relatively high efficiency of the cooling mechanism believed to operate in interstellar conditions at temperatures less than a few hundred degrees K. Sources of heat input are discussed, including low energy cosmic-ray particles, soft x rays, and the input of thermal energy, due to ionization of the interstellar gas by energetic nucleons or photons, followed by Coulomb interactions of the ejected electrons with interstellar ions. Recent investigations based on stellar abundances of Li, Be, and B, however, set an upper limit to the low-energy cosmic-ray flux which is insufficient to maintain H I clouds at ~100°K. If the energy output from O and B stars could be dissipated efficiently within interstellar clouds, however, the mean energy input within clouds could be quite high. It has been considered hitherto, however, that this store of stellar energy cannot be converted into heat with sufficient efficiency to compete with other mechanisms. The purpose of the present communication is to point out that this view may not be valid if an appreciable quantity of very small grains of radii $\sim 10^{-1}$ cm exists in interstellar clouds; it cannot be ruled out that such particles contribute up to ~1% of the mass of ordinary interstellar clouds. The cases of graphite, iron, and silicate particles are considered, and it is suggested that small grains of graphite or iron, if sufficiently abundant, may serve to thermalize the ambient H I gas in interstellar clouds to temperatures ~100°K. Such grains may possibly be responsible for the chief part of the heat gain required to maintain H I clouds at ~100°K, the grains efficiently degrading the optical energy of starlight into kinetic energy of gas atoms. (UK)

42482 EXPANSION MOTIONS IN THE INNER PARTS OF THE GALAXY. Menon, T. K.; Ciotti, J. E. (Univ. of Hawaii, Honolulu). Nature (London); 227: 579-81(8 Aug 1970).

As well as the high-velocity expansion features already known in the inner parts of the galaxy, there also seem to be expansion features at low velocities. Two new features with velocities of -27 km s^{-1} and -14 km s^{-1} at a distance of about 4.5 kpc were identified, and their relationship to the other expanding features is discussed. (auth) (UK)

42483 SEARCH FOR HARD X-RAY EMISSION FROM THE GALACTIC PLANE. Bleeker, J. A. M.; Deerenberg, A. J. M. (Kamerlingh Onnes Lab., Leiden). Nature (London); 227: 470-3(1 Aug 1970).

Rocket-borne x-ray detectors have shown excess radiation above the general x-ray background at energies of 1.4 to 18 keV coming from the region of the galactic plane $220° < l_{II} < 320°$. Various attempts to explain this radiation differ in their predictions of the flux expected at higher x-ray energies, making it desirable to search the galactic plane for x-ray emission at energies > 20 keV. An x-ray survey experiment is described, employing four balloon-borne x-ray telescopes, flown over Texas on June 14, 1969, to search for hard x-ray emission (> 20 keV) from the Galaxy. The results appear incompatible with the model that explains both the galactic x rays and gamma rays in terms of Compton scattering of sub-millimetre photons by galactic electrons, and the data, combined with data at lower energies, are consistent with a thermal origin of the galactic x-ray emission. A plasma temperature in the range 8 to 12 keV is derived. (auth) (UK)

42484 STELLAR RADIATION PRESSURE UPON SPHERICAL INTERSTELLAR DUST PARTICLES. Divari, N. B.; Reznova, L. V. (Odessa Polytechnic Inst.). Sov. Astron. AJ (Engl. Transl.); 14: 133-8(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 166-71(Jan-Feb 1970).

Tables are given for the ratio of the radiation pressure to the gravitational attraction exerted by stars of various spectral types on spherical water, quartz, and graphite particles with radii from 10^{-1} to 10^{-3} cm. The computations rest on the exact equations of the Mie theory for a wavelength-dependent complex refractive index. (auth)

42485 NUMERICAL CALCULATION OF THE EVOLUTION OF A SPHERICAL GALAXY WITH ROTATION. Dzyuba, B. M.; Yakubov, V. B. Sov. Astron. AJ (Engl. Transl.); 14: 1-5(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 3-9(Jan-Feb 1970).

A numerical solution of the equations of motion of 1000 mass points, representing approximately the mass distribution in a galaxy, is discussed. All the particles interact with each other according to Newton's law. In order to exclude the effect of near encounters, the Newtonian force of attraction is assumed to be equal to zero at sufficiently small interparticle distances. A rotating spherical galaxy with a random but uniform, on the average, distribution of particles was selected as the initial state. In the course of the numerical integration over a time of the order of two revolutions the system achieved a shape of the spiral type with a bar. The further evolution of the system is traced and it is shown that the resulting shape is relatively stable. The basic results of the calculation are presented in photocopies of figures, produced by computer, on which the spatial distribution of the particles is given. (auth)

42486 ROTATION OF GALAXIES. Vorontsov-Vel'yaminov, B. A. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 11-16(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 16-22(Jan-Feb 1970).

A critical compilation of optical and radio data on the rotation of 170 galaxies of their nuclear regions according to 212 determinations is used to investigate the periods and rotational velocities statistically. The rotation period increases somewhat from early-type spirals toward irregular galaxies and is proportional to the radius of the region of solid-body rotation. The linear velocity of solid-body rotation decreases from early spirals toward irregulars. The angular rotational velocity decreases with increasing flattening. These findings all conflict with normal expectations and the statements usually made. Well-defined spiral arms fall inside the region of solid-body rotation, thereby explaining the stability of their shape with time. Differential rotation sets in at the point where the arms or their logarithmic-spiral shape become indistinct, and conversely. (auth)

42487 PROPERTIES OF SEYFERT-GALAXY NUCLEI AND THE INTEGRATED PARAMETERS OF THE GALAXIES. Zasov, A. V.; Dibai, E. A. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 17-20(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 23-6(Jan-Feb 1970).

A probable correlation is found between the luminosity of Seyfert-galaxy nuclei and the integrated luminosity and mass of the galaxies themselves, suggesting that the level of activity in the nuclei remains approximately constant during their active phase. Photoelectric observations of eight Seyfert galaxies reveal an ultraviolet excess in the central regions beyond the nuclei; this effect could arise from a large amount of very hot gas in the inner regions of Seyfert galaxies. (auth)

42488 THERMODYNAMIC IRREVERSIBILITY AND RELAXATION IN GALAXIES. Marochnik, L. S. (Inst. of Astrophysics, Dushanbe, USSR). Sov. Astron. AJ (Engl. Transl.); 14: 36-43 (Jul-Aug 1970).

Translated from Astron. Zh.; 47: 46-55(Jan-Feb 1970).

The interaction of stars with unstable collective motions of the stars and the interstellar gas is one factor that may be responsible for the development of thermodynamic irreversibility and relaxation in systems having no stellar encounters. The instability may be of arbitrary origin. The stellar peculiar-velocity dispersion and the interstellar-gas temperature may rise through the loss of gravitational energy in the instability process. An increase with age in the velocity dispersion of Population I stars in the galactic plane of the Milky Way and other spiral galaxies may result from "collisions" between the stars and unstable density waves, with which the spiral arms should probably be identified. The value of the z disperison in the velocities of the Population I stars in spiral galaxies evidently is not determined solely by the height of the layer in which the stars of a given age were formed; the gravitational condensation of the gas toward the plane and the instability of the density waves may also contribute to the z relaxation. The relaxation in the spherical subsystems of spiral galaxies and in elliptical and irregular galaxies may result from the gravitational condensations of interstellar gas, with the rate of the process differing in different systems. (auth)

42489 CENTRAL PART OF THE COMA CLUSTER OF GALAXIES. Gorbachev, V. I. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 182-4(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 224-6(Jan-Feb 1970).

The surface number density F(r) of Coma cluster galaxies is determined from Rood and Baum's survey for objects of different types and ellipticities, and the surface distributions are converted to space densities (17 curves). A comparison with the theoretical ellipticity distribution of galaxies indicates that an excess of systems with large ellipticities is present in the outer portion of the region investigated, and a deficiency in the inner portion. A possible explanation is given. Evidence is offered that E6-E7 galaxies ought to be classified as S0. The E galaxies in clusters are, on the average, slightly brighter than the S0 galaxies. (auth)

Cosmology

Refer also to abstracts 43034 and 43055.

42490 LOG S-LOG Z DIAGRAM FOR RADIO GALAXIES AND ITS RELATION TO COSMOLOGY. Hoyle, F.; Burbidge, G. R. (Cambridge Univ., Eng. Univ. of California, San Diego, La Jolla). Nature (London); 227: 359-61(25 Jul 1970).

The log S-log Z diagram (S = flux; Z = redshift) for 69 radio galaxies from the 3CR catalogue is shown. As in the case of QSOs the diagram shows no correlation between S and Z, and it is clear that the radio luminosity function must play an important part in the situation. The data support a differential luminosity function of the form dL/L^{5}, and a connection between the radio luminosity function and cosmology is implied. Such a connection can be contemplated as arising in a Universe with many cycles, for example in the steady-state model or in some oscillating model, but it is difficult to see how such a connection could arise in the ever-expanding Friedmann models. (UK)

42491 REDSHIFT FLUCTUATIONS ARISING FROM GRAVITATIONAL WAVES. Kaufmann, W. J. (California Inst. of Tech., Pasadena). Nature (London); 227: 157-8(11 Jul 1970).

If the space between a source of photons and an observer is filled with gravitational radiation, fluctuations in the appearance of the source would be expected, analogous to the twinkling of starlight as seen through the Earth's atmosphere. In this communication fluctuations in redshift are discussed in this context. For simplicity, the treatment is restricted to the effects of plane gravitational waves. Amongst other things it is found that the largest amount of fluctuation will occur when the beam of photons is travelling perpendicular to the direction of propagation of the gravitational wave. The case is considered of an explosion near the center of the Galaxy involving two large masses being blown apart at one-hundredth of the speed of light. A redshift of 10^{-13} corresponds to a Doppler shift resulting from a relative velocity of 10^{-2} mm/s. Although such a small shift would be undetectable using ordinary astronomical techniques it should be observable using the Moessbauer effect with both the photon emitter and receiver located in a laboratory on the Earth, and by using very strong sources and measuring currents rather than counting photons the required accuracy over comparatively brief time intervals appears feasible. It has, in fact, been reported that measurements of redshifts of $z = 10^{-15}$ are within the capacity of Moessbauer experiments. It may be necessary to have the source and receiver separated by a very large distance since the largest redshift fluctuations occur when the distance between source and observer is about the same as the wavelength of the gravitational wave. Extension to the several thousand galaxies in the local supergalaxy or supercluster is discussed. It is concluded that refined techniques using the Moessbauer effect will become important tools in the detection of gravitational radiation. (UK)

42492 ANISOTROPIC STRESSES IN HOMOGENEOUS COSMOLOGIES. MacCallum, M. A. H. (Dept. of Applied Mathematics and Theoretical Physics, Cambridge, Eng.); Schmidt, B. G. Commun. Math. Phys.; 17: 343-7(1970).

A certain class of homogeneous world models filled with perfect fluid has been discussed previously. The corresponding results when anisotropic stresses are included are examined.(auth)

42493 CLOCK PROCESS AND LAW OF CONSERVATION OF ENERGY IN COSMOLOGY. Treder, Hans-Juergen (Zentralinstitut fuer Astrophysik, Potsdam, Ger.). Ann. Phys. (Leipzig); 24: 155-62(Mar 1970). (In German).

No time-like Killing vector but only a conformal time-like Killing vector exists in cosmological space-time. Therefore, the validity of a law of conservation of energy depends on the equations of state and on the choice of clocks. (auth)

42494 UNIVERSE FIELD WITH INCOHERENT MATTER AND ELECTROMAGNETIC RADIATION. Misra, R. M.; Narain, Udit (Univ. of Gorakhpur, India). Proc. Nat. Inst. Sci. India, Part A; 35: 771-8(Nov 1969).

A solution of Einstein's field equations with incoherent matter and electromagnetic radiation is presented. It is the generalized from of a solution previously obtained by Ozsvath (1966). The universe represented by it has zero expansion and shear but nonzero rotation. (auth)

42495 PARTICLES AND GEOMETRY. Wheeler, John Archibald (Princeton Univ., N. J.). pp 31-42 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

The discussion of particles and geometry proceeds from a consideration of forces on a drop of water to the Einstein theory of general relativity. The discussion covers space, superspace, and space–time geometrodynamics, and particle size and structure in the Universe. (J.F.P.)

42496 CLASSICAL AND QUANTUM DYNAMICS OF A CLOSED UNIVERSE. Misner, Charles W. (Univ. of Maryland, College Park). pp 55-79 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

A new technique, which uses Hamiltonian methods for formulating and solving the Einstein equations for homogeneous cosmological models is described. The Hamiltonian methods, the Ryan rotating model, quantum cosmology, and the quantized Robertson–Walker universes are discussed. (J.F.P.)

42497 DISTRIBUTION OF ANTIMATTER IN THE UNIVERSE. Jones, J.; Jones, B. (Cambridge Univ., Eng.). Nature (London); 227: 475-6(1 Aug 1970).

It has been shown that, if space were filled with an equal mixture of matter and antimatter, the γ-ray flux resulting from nucleon–antinucleon annihilation would be far above the observed limits. This, however, does not rule out the possibility that matter and antimatter may exist separately in large regions, perhaps in the form of galaxies and antigalaxies, or even clusters of galaxies and antigalaxies. The object in the present communication is to find a lower limit to the mass of such regions, if they exist, by using some of the basic conclusions derived from galaxy formation theories in a "big-bang" universe. It is assumed that a process existed which could separate matter and antimatter into continuous regions at some early epoch, and that the number and properties of these regions were the same, and it is further assumed that these regions remained separated until after the occurrence of decoupling, since the presence of the radiation field before decoupling would prevent collisions between them owing to the effects of radiation drag. After decoupling, the material contained in several such regions may have started to collapse and coalesce, leading to an annihilation of particles from regions and antiregions. The rate at which coalescence would have occurred would have depended on the scale of density fluctuations present at the time of decoupling. Collision cross sections would have become very high once collapse set in, so that if both matter and antimatter were present a considerable amount of annihilation would be expected at the time of collapse, and the γ rays produced would have led to an enhancement of the γ-ray energy density observed at the present epoch, which would therefore be used to set an upper limit on the amount of annihilation occurring. These findings are considered in relation to redshifts. On these premises, however, lower mass limit is greater than the assumption made; it is not feasible to support a "big bang" model of a universe that contains equal quantities of matter and antimatter. (UK)

42498 HYDRODYNAMICAL BEHAVIOR OF GAS SPHERES WITH MASSES OF 10^4 TO 10^{20} solar mass. Matsuda, Takuya; Sato, Humitaka (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 41: 1021-40(Apr 1969).

For gas spheres with masses of 10^4 M ~ 10^{20} $M_\odot$, hydrodynamical evolution, beginning from a state where the objects have become opaque, is calculated by means of an electronic computer. The effects of general relativity are included, but energy transport is neglected. The mechanism of bounce, crush, and collapse is discussed qualitatively. It is shown that gas spheres with mass greater than about 10^7 $M_\odot$ cannot escape from the final collapse because of general relativistic effects though this mass limit depends on the initial condition. Therefore, the cause of the expansion of the metagalactic system cannot be explained in terms of the bounce of a gas sphere with mass about 10^{20} $M_\odot$. (auth)

Planetary Phenomena

42499 MODULATION OF JUPITER'S DECAMETRIC RADIO EMISSION BY Io. Dermott, S. F. (Royal Military Coll. of Science, Shrivenham, Eng.). Mon. Notic. Roy. Astron. Soc.; 149: 35-44(1970).

A dc circuit model was proposed by Goldreich and Lynden-Bell (1969) to account for the modulation of Jupiter's decametric radio emission by Io. The model accounts for the observations only if the electrical resistance of Io is less than some critical resistance. These resistances were estimated and it is shown that Io's is probably the greater. It is also shown that the model probably cannot be applied to Amalthea. (auth) (UK)

42500 SEARCH FOR JOVIAN HECTOMETRIC CONTINUUM RADIATION. Weber, R. R.; Stone, R. G. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London); 227: 591(8 Aug 1970).

Essentially continuous radiation has been reported from Jupiter at low frequencies, and it has been proposed that the intense and constant radiation observed at 200 kHz from several spacecraft was chiefly of Jovian origin; also that a spectral index of 2.5 may apply from 0.20 to 20 MHz. If this is correct it should be possible to detect the Jovian continuum with the Radio Astronomy Explorer satellite RAE 1, launched on July 4, 1968. There are two methods for identifying Jovian emission with RAE 1. The first is from a scan of the main beam of the upper V antenna past Jupiter when the orbit permits, and the second is provided by a lunar occultation of Jupiter as seen by the satellite. The latter provides a more sensitive test and was investigated in detail. No evidence was found for Jovian radiation greater than the sensitivity limit of the equipment. An upper limit of about $\frac{1}{4}$ $\overline{\Lambda}$ of the background flux could be set for the Jovian continuum, based on the occultations and the satellite receiving system. The useful frequency range for the occultations was 0.54 to 5.4 MHz, and the minimum frequency for each occultation depended on ionospheric conditions and on the Jupiter–Earth–satellite geometry. At the lowest frequencies the upper limit was a factor of 20 or more below a simple power-law spectrum obtained by joining the 0.20 MHz observations with higher frequency ground-based observations. The RAE 1 upper limit rules out the suggestion of a relatively constant spectral index from 0.20 to 20 MHz for a continuum component, and also makes the 0.20-MHz observations difficult to explain in terms of Jovian emission. From RAE 1 and ground-based data it is reasonable to conclude that the radio spectrum "turns over" somewhere between 0.5 and 3 MHz. (UK)

Atomic and Molecular Physics

Refer also to abstract 42978.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 41289, 42771, 42790, 42791, 42804, 42806, and 42811.

42501 (ORNL-tr-2331) ENERGY LOSSES, RANGE, AND BREMSSTRAHLUNG YIELD FOR 10 keV TO 100 MeV ELECTRONS IN SOME SIMPLE ELEMENTS AND SOME CHEMICAL COMPOUNDS. Pages, Lucien; Bertel, Evelyne; Joffre, Henri; Sklavenitis, Laodamas (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from report CEA-R-3942. 137p. Dep. CFSTI.

An abstract of the original French report appeared as NSA 24: 12626.

42502 ENERGY LOSS OF PROTONS CHANNELLING THROUGH VERY THIN GOLD. Machlin, E. S. (Columbia Univ., New York); Petralia, S.; Desalvo, A.; Rosa, R.; Zignani, F. Phil. Mag.; 22: 101-16(Jul 1970).

The energy loss of protons channelled along the [001] direction in 500-Å thick gold was analysed as a function of emergence angle. For a given emergence angle, the energy loss can be related to a particular path along the channel and, by applying Poisson's equation to the interatomic potential, to the local electron density. The small thickness of the samples used in the present investigation, compared to prior investigations, allowed a relatively simpler and more unequivocal interpretation of the experimental data than previously possible. The relative variation in the stopping power due to channelling turned out to be much smaller than the variation in the local electron density, in satisfactory agreement with recent theoretical expectations (Bonsignori and Desalvo 1969). Also, the measurements distinguish between not too different approximations to the interatomic potential: Lindhard's (1965) potential yields agreement with experiment and Nielsen's (1956) does not. (auth) (UK)

42503 PLASMA EFFECTS ON TRANSITION RADIATION FROM METAL FOILS. Bolland, T. K. (Lehigh Univ., Bethlehem, Pa.). Phys. Rev., B: 2: 798-803(15 Aug 1970).

The transition radiation emitted from a thin metal foil bombarded by electrons is calculated, taking into account the excitation of plasma waves in the foil. The correction the plasma waves introduce varies greatly in different cases and can be of the order of 10% or greater at the frequency at which the radiation has its peak intensity (auth)

42504 ANISOTROPY OF THE SECONDARY ELECTRON YIELD AS A FUNCTION OF THE ENERGY OF THE PRIMARY ELECTRONS FROM 5 TO 50 keV. Seiler, H.; Kuhnle, G. (Univ., Tuebingen, Ger.). Z. Angew. Phys.; 29: 254-60(1970). (In German).

The total secondary electron yield $\sigma = \delta + \eta$, the true secondary electron yield δ, and the electron backscattering coefficient η of a single crystal depend on the orientation of the primary electron beam relative to the crystallographic axes. Measurements were made of σ and η, and from them δ determined as a function of the angle of incidence of the primary beam relative to the normal of the (111) face of a silicon single crystal. The magnitudes of the maxima of the yield decrease with increasing energy of the primary electrons from 5 to 50 keV. The width of the maxima does not always decrease proportionally to the wavelength of the primaries. This is explained by means of the orientation-dependent patterns obtained in the scanning electron microscope. The unproportionality is caused by the angle of inclination between the plane of the incident beam and the normal of the surface plane. (auth)

42505 MATRIX ELEMENTS OF RELATIVISTIC ELECTRONS IN A COULOMB FIELD. Gargaro, W. W.; Onley, D. S. (Ohio Univ., Athens). J. Math. Phys. (N. Y.); 11: 1191-7(Apr 1970).

Matrix elements for a radiative interaction between states of a Dirac electron in the presence of a Coulomb field are reduced to a closed analytic form in the limit of zero electron mass; corrections for finite electron mass are indicated. The application of these to inelastic electron scattering and radiation problems is discussed. (auth)

42506 THEORETICAL TREATMENT OF LOW-ENERGY ION BACKSCATTERING FROM A ROW OF GOLD ATOMS. Armour, D. G. (Univ. of Salford, Eng.); Carter, G.; Smith, A. G. Radiat. Eff.; 3: 175-81(Jun 1970).

A theoretical study of the scattering of an energetic He ion from a ⟨110⟩ row of gold atoms, to which it is incident normally, has been made. Single collisions of the ion with one gold atom or a succession of two collisions with adjacent gold atoms were investigated, using a Born–Mayer potential to define the interaction and approximate analytical expressions for the scattering equations for this potential form. The predicted trimodel dependence of the energy of the backscattered ion as a function of impact parameter on a gold atom is shown to agree well with computer based calculations of the exact ion trajectories. (auth)

42507 ATOMIC COLLISION PHENOMENA IN SOLIDS. Proceedings of an International Conference Held at Brighton, England, from 7th to 12th September, 1969. Palmer, D. W.; Thompson, M. W.; Townsend, P. D. (eds.). London; North-Holland Publishing Company (1970). 705p. 238s. (CONF-690957).

Sixty papers were presented at this Conference under the following session headings: electron channelling; atomic collision theory and radiation damage; radiation damage; sputtering; inelastic atomic collisions; ion channelling; electron excitation and photon emission; surface scattering of ions; and ion penetration profiles. Separate abstracts were prepared for the 45 papers published in this volume. Summaries only are included for the remaining 15 papers. (TSS) (UK)

For abstracts of individual papers see: 42508–42529, 42790–42811, and 42831.

42508 THE ACCURATE INTERACTION POTENTIALS CORRESPONDING TO SOME SIMPLE ATOMIC SCATTERING CROSS SECTIONS. Robinson, Mark T. (Oak Ridge National Lab., Tenn.). pp 66-84 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Theoretical studies of atomic slowing down in solids have often represented the atomic scattering by the differential scattering cross sections deduced by Lindhard as approximations to the scattering from inverse power potentials. It is instructive to regard these cross sections as exact and to derive the accurate interatomic potential functions corresponding to them. This was done, both numerically and analytically, using an inversion procedure introduced by Firsov. The latter yields an expansion from which it is found that the inverse power potential is the asymptotic limit of the exact potential at high energy and large interatomic separation. The accurate potentials are softer than the asymptotic forms and are significantly energy-dependent. A similar analysis was also made of the differential cross sections that have finite total cross sections. The corresponding potentials show a cutoff, but are softer than the hard-core potential. 16 references. (auth) (UK)

42509 LOW-ENERGY SPUTTERING: ANGULAR DISTRIBUTIONS AND SURFACE ROUGHNESS. van Veen, A.; Fluit, J. M. (Univ. of Utrecht). pp 246-57 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

The angular distribution of sputtered particles from metal single crystals showed peaks in the low-index directions. Other peaks were found in oblique directions (20° from the surface of a (100) fcc crystal). These peaks can be explained assuming the generation of surface collision chains (SCC) by the impinging ions. Oblique sputtering arises from the presence of SCC's in combination with surface vacancies. Sputtering targets always contain vacancies because of the well-known effect of regular faceting. Computer simulation of the collision processes was performed, using an appropriate Born–Mayer potential. The results were in agreement with the measured oblique sputtering yield. 12 references. (auth) (UK)

42510 LOW-ENERGY SPUTTERING OF GOLD. Colligon, J. S. (Salford Univ., Eng.); Bramham, R. W. pp 258-65 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Sputtering yields were measured for 10- to 700-eV N^+, Ne^+, N_2^+, and Ar^+ bombardment of polycrystalline gold. As the bombardment commenced, sputtering yields were found to be low, but increased with ion dose to steady values near those obtained by other workers. It is postulated that the change is due to the introduction of damage into the target. Spatial distributions of the ejected gold atoms were also measured and a predominantly cosine distribution was obtained, but with preferred ejection in directions that would be expected if the nominally polycrystalline sample contained single-crystal regions of (100) orientation. 6 references. (auth) (UK)

42511 INFLUENCE OF PLANAR CHANNELLING ON SINGLE-CRYSTAL SPUTTERING. Francken, L. (Univ. Libre, Brussels); Onderdelinden, D. pp 266-77 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Evidence for planar effects on the orientation dependence of single-crystal sputtering is given by experiments using radial ion bombardment on sperical single crystals. The interpretations proposed are based on the theory of Onderdelinden. The improvement introduced concerns the way in which the random component of the beam — responsible for sputtering — is estimated. 5 references. (auth) (UK)

42512 BACKSCATTER CURRENTS FROM SINGLE CRYSTALS UNDER keV ION BOMBARDMENT. Reuther, E. (Kansas State Univ., Manhattan); Bradford, J. N.; van Wijngaarden, A. pp 278-89 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Well-known techniques were used to measure the orientation dependence of sputtering and of backscattering of projectiles from the (111) surfaces of single crystals of Au, Ag, Al, and Si. All these crystals were bombarded by keV projectiles of H and He, while the gold and silicon crystals were irradiated by various projectiles in the mass range 1 to 40 amu. With the exception of silicon, channelling effects in both the ⟨110⟩ and ⟨100⟩ directions were studied. Results of the various experiments were: (1) For Au and Si, the observed half angles, $\psi_{\frac{1}{2}}$, showed a Z_1/E dependence characteristic of the transition region between the Lindhard high- and low-energy approximations. H and He projectiles exhibited an energy dependence more closely described by the high-energy (unscreened) approximation. (2) The observed Z_2 dependence of $\psi_{\frac{1}{2}}$ could not be correlated with theory. (3) Integral count backscattering of H, He, and N from gold led to $\psi_{\frac{1}{2}}$ values close to the corresponding $\psi_{\frac{1}{2}}$ values obtained by sputtering techniques. (4) The $\psi_{\frac{1}{2}}$ value for H and He on gold decreased with increasing penetration depth, in a similar manner as observed by Bergström et al. 4 references. (auth) (UK)

42513 THE APPLICATION OF THE DEVIATION THEORY TO PATTERNS OBTAINED FROM FACETED SURFACES OF FACE-CENTERED-CUBIC METALS. Cunningham, R. L.; Ng-Yelim, Joyce (Dept. of Energy, Mines and Resources, Ottawa). pp 290-7 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

The concepts of the focuson deviation theory are applied to faceted rather than nominal surfaces of ion-bombarded single crystals. It is shown that data on the deviations of ⟨110⟩ focusons intersecting stable {110} and {114} type surfaces are sufficient to predict the deviations from nominal {100} and {111} surfaces composed largely of {110} and {114} facets after bombardment. 9 references. (auth) (UK)

42514 DEPENDENCE OF TARGET SPUTTERING ON ANGLE OF INCIDENCE OF BOMBARDING PARTICLES. Firsov, O. B. (Inst. of Atomic Energy, Moscow). pp 301-6 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

The angle of incidence of bombarding particles that corresponds to the maximum target sputtering yield is assumed to be determined by a condition that over a distance passed by a particle in the target layer responsible for the sputtering (without accounting for scattering in the first approximation), the particle should be scattered at an angle appreciably larger than the glancing angle (it is taken to be four times as large). Hence, the angular dependence of the maximum sputtering yield was found to depend on the atomic numbers of the bombarding particles and the target material, as well as on the target density and the bombarding particle energy (for energies not lower than a few kilovolts). 11 references. (auth) (UK)

42515 SPUTTERING STUDIES WITH SELECTED TARGETS. A. EJECTION PATTERNS FROM DIAMOND TYPE SEMICONDUCTORS. B. ENERGY SPECTRA OF IONS SPUTTERED FROM Cu. MacDonald, R. J.; Dennis, E.; Zwangobani, E. (Australian National Univ., Canberra). pp 307-23 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Two aspects of sputtering are described: firstly, the spatial distribution of atoms ejected from single crystals of diamond-type semiconductors bombarded with argon ions in the range 5 to 15 keV; secondly, recent measurements of the energy spectra of ions emitted from Cu targets bombarded with 10-keV Ar ions. 25 references. (auth) (UK)

42516 MECHANISM FOR SPUTTERING OF NONMETALS BY SLOW MULTIPLY CHARGED IONS. Parilis, E. S. (Inst. for Electronics, Tashkent, USSR). pp 324-7 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Theoretical consideration is given to a suggested mechanism, in which the Auger ionization of target atoms causes an accumulation of positive charge just beneath the bombarded surface, and this is followed by ejection of target ions by Coulomb repulsion. 7 references. (auth) (UK)

42517 YIELD OF POSITIVE AND NEGATIVE IONS OF METALLIC AND SEMICONDUCTOR TARGETS BOMBARDED BY Ar^+ IONS OF 40 keV. Jurela, Z. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 339-49 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Targets of the metals Mg, Al, Mn, Co, Ni, Cu, Mo, Ag, Ta, W, Pt, and Au and targets of the semiconductors Si, Ge, and C (graphite) were bombarded with Ar^+ ions of energy of 40 keV, at room temperature with a residual pressure of 2×10^{-6} torr, incident angle of 45°, and beam density of about 60 and 100 $\mu A/cm^2$. Measurements were made of the coefficients K_+ (ion/ion) of secondary positive ion emission at 90° to the incident beam. The corresponding negative ion yields K_- were measured under similar conditions for eleven of these targets. From these results the values of the degrees of ionization a_+ and a_- (the numbers of secondary positive and negative ions per sputtered neutral atom) were calculated by using known values of the appropriate neutral sputtering yields. It is shown that the dependences of K_+ and a_+ on the atomic number Z of the target element are very similar to each other and to the Z dependence of $(I' - \phi)^{-1}$ where I' is a corrected value of the target ionization energy and ϕ is the surface work function. The variation with Z of the values of a_-/a_+ is found to be similar to that of $(\phi - A)^{-1} \cdot (I' - \phi)$ where A is the electron affinity of the target atoms. 12 references. (auth) (UK)

42518 SHELL EFFECTS IN LOW-ENERGY ATOMIC COLLISIONS. Cheshire, I. M.; Poate, J. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 351-60 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

It is now appreciated that the periodic dependence of electronic stopping powers of channelled ions can be correlated with variations in the electronic density in the outer regions of the ion. Previous calculations of the authors, using the Firsov model modified to incorporate shell effects, have been extended to recent ⟨110⟩ data for gold. The energy loss for the ⟨110⟩ and ⟨111⟩ channels of silicon is also compared. Current heavy ion channelling experiments have led to the suggestion that interatomic potentials also have an oscillatory dependence on Z_1. The electronic wave functions of the previous calculations were used to construct simple Hartree potentials that show similar features to experiment. 23 references. (auth) (UK)

42519 CRITICAL EXAMINATION OF MODIFIED FIRSOV THEORY OF INELASTIC ENERGY LOSS IN ATOMIC COLLISIONS. Bhalla, C. P.; Bradford, J. N.; Reese, G. (Kansas State Univ., Manhattan). pp 361-73 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Theoretical results of S_e (electronic stopping power), with the Hartree–Fock–Slater atomic model, are presented for amorphous carbon. The average flux is calculated by $\Sigma_i \omega_i \rho_i \langle v_1^2 \rangle^{1/2}$ where ω_i and ρ_i are the number of electrons and the radial charge distribution of a subshell specified by i. The root-mean-square velocity is equal to $\langle v_1^2 \rangle^{1/2}$, which depends critically on the atomic model (Clementi or HFS) when the radial wave functions are expected to have nodes. The oscillating Z_1 behavior of S_e can be understood with the HFS model. The theoretical predictions of the absolute values cannot, however, be considered reliable unless the appropriate values of the minimum impact parameter are calculated with the inclusion of the effects due to multiple scattering and the acceptance angles for detection. Comparisons of S_e are presented for the "equipotential" plane taken to be half-way between the two colliding atoms with results obtained by calculating the plane position on the basis of HFS potentials. Numerical results are also presented when the average electronic flux does not include the contribution of the inner electrons, and it is concluded that the theoretical electronic stopping power is about the same (within 8%) as for the "full" fluxes. It is suggested that additional experimental data for amorphous targets with $Z \geq 20$ are desirable. Furthermore, single collision experiments will be extremely useful for the theoretical developments, provided these can be performed for small angles (≈2°). Finally, the observations of characteristic x rays (or Auger electrons) would have a strong bearing on the modified (semiclassical) Firsov model. 14 references. (auth) (UK)

42520 ENERGY DEPENDENCE OF CHANNELLED ION ENERGY LOSS SPECTRA. Datz, S.; Moak, C. D.; Appleton, B. R.; Robinson, M. T.; Oen, O. S. (Oak Ridge National Lab., Tenn.). pp 374-87 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Channelled-ion energy loss spectra were used to obtain information on potential parameters and differential stopping power functions. The theoretical model used was cross-checked by measuring the energy dependence of the energy loss structure for 15.0-, 21.6-, 29.4-, 38.4-, 48.6-, and 60-MeV (equal velocity increments) ^{127}I ions in Au channels and correlating these with the pathlength dependence of the structure at 15.0, 21.6, and 60 MeV. 5 references. (auth) (UK)

42521 ENERGY LOSS OF CHANNELLED PROTONS IN THE MeV REGION. Clark, G. J.; Morgan, D. V.; Poate, J. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 388-99 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Measurements of the stopping powers of channelled protons in the MeV region for a wide variety of materials are presented and a method is advanced to separate out their impact-parameter dependence. Results are discussed in terms of possible energy-loss mechanisms. An explanation is offered for the difference observed in the Si and Ge channelling ratios, which had previously appeared to be anomalous. 17 references. (auth) (UK)

42522 UNI-DIRECTIONAL CHANNELLING AND BLOCKING. Appleton, B. R. (Oak Ridge National Lab., Tenn.); Feldman, L. C. pp 417-33 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

An experimental method which utilizes both the channelling and blocking effects of energetic ions in single crystals in a simple geometry is presented. This method, called the un-directional channelling and blocking technique, retains the sensitivity of double-alignment techniques as well as the experimental simplicity and efficiency of the channelling single-alignment configuration. Measurements of the scattering yields for ZnO, W, and Ge and of the temperature dependence of W are compared to calculations based on the Lindhard model and to recent Monte Carlo computer calculations. 6 references. (auth) (UK)

42523 CHANNELLING TO RANDOM TRANSITION. Chadderton, Lewis T.; Krajenbrink, Frans G. (North American Rockwell Corp., Thousand Oaks, Calif.). pp 456-75 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

A conventional classical approach to channelling of fast charged particles presupposes division of an incident beam by the crystal into two components—aligned and random. Experience with electrons, however, and extrapolation of concepts consequent upon a "correspondence principle," leads to the prediction of a third component that is short-lived but whose unique properties should be detectable. Transmission experiments are described in which very thin crystals were used to observe particles that are quasi-channelled, as distinct from those that are blocked. It was shown that aligned, repetitive quasi-channelled orbits yield anomalously high energy losses, violate critical angle concepts, and dominate patterns seen in transmission. This new process is a product of a progressive rather than abrupt angular breakdown of the continuum potential concept in the channelling-to-random transition. Quasi-channelling is detectable in high-angle Rutherford scattering from single crystals as a damped oscillatory function of yield with depth. It was shown that in this case the entry surface may be regarded as a defect responsible for the initiation of quasi as well as proper channelled orbits. When defects are present in depth, because of irradiation damage, implantation, or cold work, local increases in disorder (entropy) and accompanying strain catalyze the proper channelling → quasi-channelling → dechannelling → random transition. As a direct consequence there are "image widths" for individual defects in excess of the size of the defects themselves. There is also an enhanced probability of high-angle scattering. The effect is discussed briefly for specific defects. 19 references. (auth) (UK)

42524 ION SCATTERING AND LIGHT EMISSION. Parilis, E. S. (Inst. for Electronics, Tashkent, USSR). pp 513-35 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

The theory of fast ion scattering on a solid surface has been subject to a series of approximations. In the early period of research the interpretation of experimental data was based on the assumption that the scattering solid was an entity, and efforts were made to find facts that would confirm the analog with scattering by a solid wall (smooth or rough). The latest research shows that single scattering from the surface atoms, double scattering from two neighboring atoms, multiple scattering by surface atomic chains, and semi-channels play an important role. The bombardment of solids with atomic particles results not only in corpuscular emission but also in photon radiation, which covers a wide spectral range, and with high-energy ions can reach into the range of x rays. There are several basic mechanisms for the emission of light during ion bombardment. One or another mechanism may dominate depending on the ion energy, its charge, and the nature of the solid. The basic types of light emission under ion bombardment are the following: emission of light by excited atoms that had been sputtered or reflected from the surface of the solid, luminescence, characteristic x-ray production, bremsstrahlung, and transition radiation under the impact of singly and multiply charged ions. Emphasis here is on emission by excited atoms and ions that escape the surface of solids under the ion impact since it is better studied. 82 references. (auth)

42525 CHARACTERISTIC X-RAY GENERATION BY HEAVY-PARTICLE IRRADIATION OF COPPER. Cairns, J. A.; Holloway, D. F.; Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). pp 541-52 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

A systematic study was made of the generation of x rays from a target by a series of energetic ion beams. Attention is drawn to some of the precautions necessary to ensure accumulation of valid data. A new Z_1 periodic dependence for x-ray production is described. It is shown how the simultaneous measurement of x rays from projectile and target with increasing projectile energy yields an insight into inelastic energy-loss mechanisms. 6 references. (auth) (UK)

42526 COMPUTER SIMULATIONS OF ION REFLECTION AND PENETRATION INTO SINGLE CRYSTALS. Pryde, M. (Regional Coll. of Tech., Liverpool); Smith, A. G.; Carter, G. pp 573-88 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Two computer simulations of the backscattering of low-energy Ar ions from Au and the penetration of low-energy He ions into W were performed. In the first a binary collision model was assumed, using an appropriate Born–Mayer interaction potential between Ar and Au atoms and collisions were treated as a sequence of successive two-body events. In the simulation the incident ion interacts with one atom of a symmetrical row in a (100) plane and suffers a collision that either results in its immediate backscattering, its scattering on to a further atom of the row and then backscattering, or its penetration into the lattice. Initial ion energies are in the range 10 eV to 5 keV and interaction forces are cut off when distances from two scattering atoms are equal. Normal incidence only is assumed and only events from one or two successive scatterings are treated. The complete trajectory of the scattered ion is not evaluated, but scattering angles and energy loss in each collision are enumerated. The simulations show that, at all incident ion energies and at certain scattering angles, the backscattered ion will possess three distinctly different energies. The intermediate energy results from a single backscattering collision and the higher and lower energies result from two consecutive collisions. Previous simulations and experiments suggested the existence of the higher and intermediate recoil energies, but the present simulation indicates that a lower energy recoil should occur with a similar probability to the higher energy recoil. Effective backscattering cross sections from a row of atoms are evaluated. In the energy range considered backscattering is confined to impact parameters small compared to the lattice interatomic spacing, so that binary collision events are justified. In the second study the interest is centered on the penetration of incident He ions through a square mesh of simulated W atoms, again using an appropriate Born–Mayer interatomic potential. Most of the interest is concerned with impacts close to the axis of the mesh, such that multiple co-operative forces are important. Consequently the trajectory of a He ion in the range 1 eV to 1 keV was evaluated for impacts in the mesh between the central axis and the boundary of the mesh. The trajectories are evaluated by computation of instantaneous forces and the use of classical equations of motion, and are analyzed to evaluate for what impact parameters the ion will penetrate the mesh. These parameters that, at any point in the mesh, result in ion backscattering, delineate an area within which an ion will certainly penetrate the mesh, and the ratio of this area to the mesh area gives an ion entrance probability. These probabilities are evaluated as a function of energy and are compared with theoretical binary collision estimates and experimental evaluation of entrance probability. 22 references. (auth) (UK)

42527 LOW-ANGLE SCATTERING OF He^+ IONS AT A W CRYSTAL SURFACE. Farmery, B. W.; Marwick, A. D.; Thompson, M. W. (Univ. of Sussex, Brighton, Eng.). pp 589-605 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

A tungsten crystal was prepared with a surface macroscopically flat to within 2000 Å over an area several mm in diameter. The surface was close to a {110} plane. A finely collimated beam of He^+ ions was scattered by this crystal on to a fluorescent screen that could be photographed. The angle of incidence, relative to the plane surface, could be varied from 0° to 10° to a precision better than 0.1°. In the range 30 to 300 keV the ion beam used was from the University of Sussex Dynagen accelerator. Experiments in the range 0.3 to 2 MeV were performed at Chalk River on a Van de Graaff machine. At large angles of incidence a typical blocking pattern was observed on the screen, characteristic of multiple scattering of ions penetrating a cubic crystal lattice. It was found,

however, that this pattern was cut off for emission directions closer than about 1° to the surface. At grazing incidence, close to low-index directions, a bright spot was observed at an emission angle equal to angle of incidence. This disappeared for angles of incidence greater than about 1°. By using fluorescent screens with an energy filter (formed by an evaporated overlayer of aluminium) it was possible to demonstrate that the bright spot was formed by scattered ions whose energy was close to that of the incident ions. It is suggested that the effective potential of atoms near the surface produces a refraction effect for emerging ions similar to that producing planar blocking, and reflection of ions without significant penetration, for small angles roughly corresponding to those in channelling. 11 references. (auth) (UK)

42528 EXPERIMENTAL STUDY OF SPATIAL AND ENERGY DISTRIBUTIONS OF IONS SCATTERED BY CRYSTALS. Mashkova, E. S.; Molchanov, V. A.; Skripka, Yu. G.; Snisar, V. A.; Soshka, W. (Moscow State Univ.). pp 606-14 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

The spatial and energy distributions of ions scattered by copper and silicon crystals were studied. Strong anisotropy of the spatial distribution of scattered ions was observed. Other directional effects (inlet and outlet blocking effects, scattered ion energy loss behavior) were also studied. 7 references. (auth) (UK)

42529 MULTIPLE SCATTERING OF LOW-ENERGY HEAVY PARTICLES. Bernhard, F.; Lippold, J.; Meyer, L.; Schwabe, S.; Stolle, R. (Humboldt-Univ., Berlin. Festkoerperphysik, Berlin). pp 663-75 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Some new theoretical and experimental results are reported for the multiple scattering of low-energy heavy particles. The angular distribution was calculated in a way similar to the well known theory of Molière, but using a differential cross section calculated from classical mechanics for a screened Coulomb potential. The scattering distributions were measured for lithium ions in carbon and aluminium within the energy range from 10 to 100 keV. The agreement between experimental and theoretical values was satisfactory. 11 references. (auth) (UK)

Atomic and Molecular Properties

Refer also to abstracts 42312, 42852, 42934, and 42997.

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 42884 and 42928.

42530 OBSERVATION OF MUONIC X-RAYS IN HYDROGEN GAS. Placci, A. (CERN, Geneva); Polacco, E.; Zavattini, E.; Ziock, K.; Carboni, C.; Gastaldi, U.; Gorini, G.; Torelli, G. Phys. Lett.; 32B: 413-15(3 Aug 1970).

Using a proportional gas counter, de-excitation muonic x-rays from a μp atom, formed by stopping negative muons in a hydrogen gas target, were detected. (auth)

Collision Phenomena

Refer also to abstract 42350.

42531 (UCRL-19594) ELECTRON IMPACT EXCITATION EFFICIENCY CURVES FOR THE FORMATION OF NEUTRAL METASTABLE SPECIES. Newton, Amos S.; Thomas, G. E. (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1970. Contract W-7405-eng-48. 3p. (CONF-700607-2). Dep. CFSTI.

From 18th Annual Conference on Mass Spectrometry and Allied Topics, San Francisco, Calif.

A method of making RPD measurements of the excitation efficiency curves for formation of neutral electronically metastable species by crossing an electron beam with an atomic or molecular beam is described briefly. The method is based on use of a pulsing scheme to distinguish photons from metastables. A diagram of the pulsing scheme and an example of its application of N_2 are included. (A.G.W.)

42532 IMPACT-PARAMETERS DEPENDENCE OF VIBRATIONAL EXCITATION CROSS SECTIONS FOR H_2 + He COLLISIONS. Micha, David A. (Univ. of Florida, Gainesville); Rotenberg, Manuel. Chem. Phys. Lett.; 6: 79-82(15 Jul 1970).

Differential and integral vibrational excitation cross sections for H_2 + He were obtained from a coupled-channel calculation using an optical-potential approach. A comparison is made with results of the modified-wave-number approximation. Angular distributions are found to be strongly peaked in the forward center-of-mass direction. (auth)

42533 SODIUM ^2P FINE-STRUCTURE TRANSITIONS IN COLLISIONS WITH HELIUM. Reid, R. H. G.; Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Chem. Phys. Lett.; 6: 85-6(15 Jul 1970).

Based upon the interaction of Baylis (J. Chem. Phys.; 51: 2665 (1969)), a close-coupled partial-wave calculation of the cross section for fine-structure transitions in Na($3p^2P$) in collisions with He was carried out that yields cross sections in harmony with the experimental value. The agreement provides strong support of the theoretical description of the process and of the model used by Baylis to calculate the interaction. (auth)

42534 ELECTRONIC EXCITATION OF K ATOMS IN COLLISIONS WITH DIATOMIC MOLECULES: THRESHOLDS AND ENERGY DEPENDENCE FROM 1 TO 5 eV. Kempter, V.; Mecklenbrauck, W.; Menzinger, M.; Schuller, G.; Herschbach, D. R.; Schlier, Ch. (Univ., Freiburg i. B.). Chem. Phys. Lett.; 6: 97-100(15 Jul 1970).

A velocity-selected atomic potassium beam produced by sputtering was utilized to study collisional excitation of K atoms by diatomic molecules. K^* (4^2P) was detected by its radiative decay. For N_2, NO, and O_2 the excitation thresholds coincide with the endoergicity of the $4^2S \rightarrow 4^2P$ transition, 1.6 eV (cms), whereas for CO the threshold occurs at 2.1 eV. The cross sections rise about linearly with velocity above threshold and are of the order of 2Å^2 at 4 eV. (auth)

42535 OPACITY ANALYSIS OF INELASTIC MOLECULAR COLLISIONS: EXPONENTIAL APPROXIMATIONS. Levine, R. D.; Balint-Kurti, G. G. (Hebrew Univ., Jerusalem). Chem. Phys. Lett.; 6: 101-5(15 Jul 1970).

An extension of the range of applicability of the Born and distorted-wave Born scattering matrices is made using an exponential approximation. Computational results for vibrational and rotational excitation are presented. The present techniques bridge the gap between the weak coupling and the dominant coupling regimes in the opacity function. (auth)

42536 COLLISIONAL EXCITATION AND IONIZATION OF K ATOMS BY DIATOMIC MOLECULES: ROLE OF ION-PAIR STATES. Lacmann, K.; Herschbach, D. R. (Harvard Univ., Cambridge, Mass.). Chem. Phys. Lett.; 6: 106-10(15 Jul 1970).

Cross sections for excitation of potassium atoms to K^* (4^2P) and for ionization to K^+ were measured as a function of collison energy (1 to 20 eV cms) for HCl, Cl_2, N_2, CO, NO, and O_2. The results are correlated with potential curve crossings involving electron transfer to the target molecule. (auth)

Atomic Theory

Refer also to abstract 42894.

42537 OSCILLATOR STRENGTHS FOR THE EXCITED STATES OF HELIUM-LIKE SYSTEMS. Safronova, U. I.; Ivanova, A. N.; Kharitonova, V. N. Opt. Spectrosc. (USSR) (Engl. Transl.); 28: 313-14(Mar 1970).

Translated from Opt. Spektrosk.; 28: 585-8(Mar 1970).

The zeroth- and first-order perturbation calculation of the matrix element of the dipole moment for two-electron systems is examined. The results are used to calculate oscillator strengths to second order. Values are tabulated for He, Li^+, Be^{3+}, and C^{4+}. (A.G.W.)

42538 DERIVATION OF NECESSARY CONDITIONS ON HARTREE–FOCK ORBITALS. Dahl, J. P.; Johansen, H.; Truax, D. R.; Ziegler, T. (Univ. of Copenhagen). Chem. Phys. Lett.; 6: 64-6(15 Jul 1970).

The Hartree–Fock equations for an N-electron system are derived without the use of Lagrangian multipliers. The derivation is shown to be entirely equivalent to that applying the Lagrangian multiplier technique. (auth)

Cosmic Radiation

Refer also to abstracts 42476, 42871, and 42875.

42539 (AECL-3657) COSMIC RAY NM-64 NEUTRON MONITOR DATA, CHACALTAYA, BOLIVIA. III. JANUARY-DECEMBER 1969. Anda, R.; Mejia, G. R.; Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Universidad Mayor de San Andres, La Paz (Bolivia). Laboratorio de Fisica Cosmica). Jun 1970. 56p. (In English and Spanish). Dep. CFSTI (U. S. Sales Only). AECL $1.50.

Uncorrected and barometer-corrected results from the cosmic-ray station at Chacaltaya, Bolivia, are given in tabular form from January to December, 1969. Normalized graphs of the neutron monitor and of the barometric pressure are also given. (auth)

42540 INTERACTION BETWEEN COSMIC-RAY ELECTRONS AND COSMIC-RAY PROTONS. Melrose, D. B.; Wentzel, D. G. (Univ. of Maryland, College Park). Astrophys. J.; 161: 457-76 (Aug 1970).

Anisotropic cosmic-ray protons generate hydromagnetic waves. In this generation process, the momentum transfer scatters the protons. Anisotropic cosmic-ray electrons scatter either by amplifying or by absorbing the waves generated by the protons. Results are: (1) Streaming cosmic-ray protons tend to drag the electrons along with them, affecting the confinement of electrons to the galactic disk. (2) Waves generated by protons scatter the electrons made anisotropic by synchrotron radiation, so that a future measurement of electron anisotropy may inform us of the dynamics of cosmic-ray protons. (3) In a varying magnetic field, electrons absorb some of the proton-generated waves and are thereby accelerated, while all cosmic rays experience a Fermi-type acceleration. These accelerations are probably not significant. An appendix treats the range in the waves' angles of propagation and criteria for the usual assumption of parallel propagation. (auth)

42541 SOME REMARKS ON THE POSSIBLE ORIGIN OF SUPERHEAVY NUCLEI IN PRIMARY COSMIC RAYS. Bandyopadhyay, P.; Chaudhuri, P. Ray (Indian Statistical Inst., Calcutta). J. Phys., A (London); 3: L33(Jul 1970).

Neutron stars (pulsars) are proposed as the sources of superheavy (SH) nuclei $Z \geq 110$ in primary cosmic rays. Taking into account the 1969 result of Berlovich and Novikov that these SH nuclei can be formed by the r process when the temperature is greater than 1.8×10^{9}°K and at sufficiently high neutron number density, it is pointed out that this temperature condition can prevail in a neutron star for approximately 10^{3} years when the cooling behavior is governed by the synchrotron radiation of neutrinos according to the photon-neutrino weak coupling theory. On the basis of this result, it is argued that the formation of SH nuclei in the Galaxy can be considered as a continuous event. Finally, some remarks are made about the expected flux of these SH nuclei. (auth) (UK)

42542 UHF RADIO PULSES ASSOCIATED WITH EXTENSIVE AIR SHOWERS AT LARGE ZENITH ANGLES. Fegan, D. J. (University Coll., Dublin). Nature (London); 227: 156-7(11 Jul 1970).

It is stated that several experiments have been successful in detecting such pulses. These experiments indicated that the energy spectrum of the radio pulses falls with increasing frequency between 30 and 550 MHz, and that the shower threshold for detecting uhf pulses is $>2 \times 10^{15}$ eV for showers incident from the zenith. Below 100 MHz the radio pulses arise through a coherent emission mechanism, but above this frequency the question of coherent or incoherent emission remains open. Observations are described at 550 MHz, at a zenith angle of 70°, using more sensitive radio receivers and a more selective trigger than used in earlier experiments, and the system used is described in detail, together with the method of data analysis employed. The experiment verified the earlier observation of uhf radio pulses at large zenith angles. The pulses showed considerable time structure, with very fast leading edges. No attempt is made to evaluate the emission mechanism. (UK)

42543 CHARGE SPECTRUM OF VERY HEAVY COSMIC-RAY NUCLEI. Fowler, P. H.; Clapham, V. M.; Cowen, V. G.; Kidd, J. M.; Moses, R. T. (Univ. of Bristol, Eng.). Proc. Roy. Soc. (London), Ser. A; 318: 1-43(21 Jul 1970).

Large areas of photographic emulsion were flown on balloons, at small atmospheric depths, in order to record tracks of relativistic highly charged nuclei of the cosmic radiation. Sixty tracks due to relativistic nuclei with $Z > 40$ were found, and the resulting charge spectrum is presented. One nucleus with $Z > 90$ penetrated the detector, indicating a lower flux of extremely heavy nuclei than was suggested by the previous experiment (Fowler, Adams, Cowen & Kidd, 1967). The observed structure in the charge spectrum again suggests that nuclei of the cosmic radiation are synthesized by the process of rapid neutron capture. Detailed consideration is given to the fundamental assumptions made in the interpretation of the measurements and assignment of the charges. (auth) (UK)

42544 ENERGY AND RADIAL DEPENDENCE OF AIR SHOWER RADIO PULSES. Hough, J. H.; Prescott, J. R. (Univ. of Calgary, Can.). Nature (London); 227: 590-1(8 Aug 1970).

An experiment is described to determine the dependence of the radio-pulse amplitude of air showers on primary energy and core distance, using part of the 22.25-MHz dipole array at Penticton, British Columbia and scintillation counters to determine the direction of the incident shower, the location of its axis, and the shower size. Receivers with a bandwidth of 4 MHz amplified the antenna signals, which were then linearly detected and displayed on an oscilloscope, the face of which was photographed whenever an air shower was detected by the scintillation counters. The correct position of any associated radio pulse could then be accurately determined on the time base. Showers were selected for analysis solely on information derived from the scintillator array, and the method of measurement of the corresponding radio traces is described. There were 750 hours of observation between October 1969 and January 1970, and 244 showers were analyzed. The corresponding mean primary energies and the rms radio pulse amplitude for sets of pulses were determined, and the dependence of this amplitude on primary energy is shown graphically. Results indicated that the initial radiation is almost certainly coherent. For coherence, radiation must arrive at the antenna within a time interval of the order $\frac{1}{2}\pi\nu$, where ν is the antenna frequency. This implies a limiting height of origin in the atmosphere below which the radiation from different parts of the shower would appear incoherent to the observer. As the primary energy increases the shower maximum occurs lower in the atmosphere, and if the maximum is below the coherence region most of the shower particles will not contribute coherently to the radiation, with a consequent reduction in signal amplitude. For the reported observations, for which the operating frequency was 22 MHz and the maximum observing distance from the shower core ~80 m, the minimum height for coherent radiation was ~1 km. The high-energy showers recorded had their shower maximum near 4 km; which means that almost all the shower particles were produced in the coherent region. It was possible to infer, from the experimental observations, the dependence of the radio pulse amplitude on distances from the shower core between 5 and 50 m. The observations are stated to be the first at distances very close to the shower axis. (UK)

42545 LATERAL DISTRIBUTION OF ELECTRONS IN EXTENSIVE AIR SHOWERS (COMPARISON BETWEEN THEORY AND EXPERIMENT). Dupuy, Jean; Cachon, Andre; Capdevielle, Jean-Noeel (Observatoire du Pic du Midi, Bagneres-de-Biogorre, France). Compt. Rend., Ser. B; 270: 1633-6(22 Jun 1970). (In French).

The experimental results and those derived from the method of cosmic-shower simulation are compared. The results demonstrate the validity of the calculations. An example of the inelasticity of high-energy nuclear reactions is given (10^{15} to 10^{16} eV). (tr-auth) (France)

42546 MAGNETIC FIELDS OF METEOR STREAMS AS A POSSIBLE MECHANISM FOR THE DIFFUSION OF COSMIC RAYS IN CIRCUMSOLAR SPACE. Bel'skii, S. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Astron. AJ (Engl. Transl.); 14: 163-6(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 201-5(Jan-Feb 1970).

On the basis of a previous estimate for the strength of the magnetic fields formed in meteor streams by the motion of charged micrometeoroids through the interplanetary plasma, it is suggested that the magnetic fields of meteor streams may make an important contribution to the diffusion of cosmic rays in circumsolar space. A comparison is made between evidence reported in the literature for a cloud of magnetic irregularities, as inferred from experimental data on the propagation of solar and galactic cosmic rays, and the distribution of the orbital parameters of meteor streams; close agreement is found. (auth)

42547 COSMIC-RAY ELECTRONS IN THE GALAXY. Razin, V. A. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 14: 44-6(Jul-Aug 1970).

Translated from Astron. Zh.; 47: 56-9(Jan-Feb 1970).

The differential energy spectrum of the primary cosmic-ray electrons near the Earth in the energy range 0.1 to 40 BeV is closely approximated by the function $I(\epsilon) = 1.4 \cdot 10^{10}\, \epsilon^{-2.5}\, (3.8 \cdot 10^{6}\, \epsilon^{-2} + 1)^{-1}$ electrons $m^{-2}\, sec^{-1}\, sr^{-1}\, BeV^{-1}$ ($\epsilon = E/mc^{2}$) that describes the energy distribution of the cosmic-ray electrons in interstellar space, provided that stationary conditions prevail there and ionization energy losses are important. The frequency spectrum of the cosmic radio-emission intensity, as

calculated for the case where the relativistic electrons have the energy spectrum $I(\epsilon)$, agrees very satisfactorily with the observational data. This agreement suggests that the energy spectra of the cosmic-ray electrons near the Earth and in interstellar space are similar, and also perhaps that the cosmic-ray particles are localized primarily in the galactic disk or the spiral arms. (auth)

42548 DETECTION OF 500 MHz RADIATION FROM COSMIC-RAY AIR SHOWERS. Charman, W. N. (Atomic Energy Research Establishment, Harwell, Eng.). Lett. Nuovo Cim.; 3: 845-8 (27 Jun 1970).

Observations were made at 500 MHz to confirm the existence of ultrahigh frequency emission from extensive air showers, and to clarify the question of its coherence. The radio system used consisted of three broadband triangular dipoles placed $\lambda/2$ apart and $\lambda/6$ above a conducting screen at ground level. (J.F.P.)

Fluid Physics

42549 STABILITY OF NONDISSIPATIVE COUETTE FLOW WHEN A CURRENT FLOWS PARALLEL TO THE AXIS. Pathak, Ram Shankar (Banaras Hindu Univ., India). Proc. Nat. Inst. Sci. India, Part A; 35: 788-801(Nov 1969).

The criterion for stability is derived by an examination of the stability of the basic flow to arbitrary perturbations. Various quantities describing perturbation have (t, θ, z) dependence given by $e^{i(pt+m\theta+kz)}$, where p is a constant (which can be complex), m an integer (positive, zero or negative) and k the wave number of the disturbance. The stability for general values of m is examined. The periods of oscillation were obtained for various values of the angular velocity under different strengths of the current. (auth)

Geophysics (Upper Atmosphere)

Refer also to abstract 42724.

42550 (HSA-148) EFFECT OF IRREGULARITY SHAPE ON RADIO-STAR AND SATELLITE OSCILLATIONS. Singleton, D. G. (Weapons Research Establishment, Salisbury (Australia)). Jul 1969. 36p. Dep. CFSTI (U. S. Sales Only).

Current models of F-region irregularities include field-aligned columns, field-aligned sheets, and frontal irregularities which extend many kilometers in the horizontal direction. An irregularity model is put forward which includes these shapes as special cases. Using this model and diffraction theory, a theoretical investigation is made of the effect these shapes have on (a) the nature of the variation of scintillation index with the zenith angle and azimuth of the direction of propagation at a point on the ground and (b) the shape and orientation of the characteristic ellipse of the amplitude diffraction pattern observed at the ground. It is shown that there are characteristic differences in effects (a) and (b) for each type of shape considered. The possible detection of these differences experimentally and the consequent conclusions that could be drawn regarding the nature of the scintillation-producing irregularities are also discussed. (auth) (Australia)

42551 (LA-4245) EARLY RADIO FLASH FROM A LOW-ALTITUDE AIR BURST. Suydam, B. R. (Los Alamos Scientific Lab., N. Mex.). Aug 1969. Contract W-7405-eng-36. 21p. Dep. CFSTI.

This report reworks an earlier theory of the early part of the radio flash from a low air burst by extending the results to quite general gamma ray vs. time histories, and to times about ten times longer than the earlier theory. The previous theory is also improved in that error estimates are given for all approximations used. Typical signal shapes are presented. (auth)

42552 (LA-4348) COMPTON CURRENT IN PRESENCE OF FIELDS FOR LEMP 1. Longley, H. J. (Los Alamos Scientific Lab., N. Mex.). 5 Jan 1970. Contract W-7405-eng-36. 33p. Dep. CFSTI.

This is a companion report to LA-4346 and LA-4347. If a Compton electron is produced by a gamma ray of energy E_γ in air and with an electromagnetic field (E_z, E_θ, B_φ) present, it will slow to a stop at an average position (DX,DY). DX is the average distance the electron travels in the direction of the gamma ray and DY is the average distance the electron travels perpendicular to the direction of the gamma ray. This report gives, as a final result, the nonlinear fitted values of the functions $DX(E_\gamma, E_\theta, E_r, B_\varphi)$ and $DY(E_\gamma, E_\theta, E_r, B_\varphi)$. The uses of DX and DY in LEMP 1 are discussed. (auth)

42553 SCATTERING FROM A TURBULENT PLASMA. Guthart, H.; Graf, K. A. (Stanford Research Inst., Menlo Park, Calif.). Radio Sci.; 5: 1099-1118(Jul 1970).

The scattering of electromagnetic waves from a dense turbulent plasma was examined experimentally. The experiments include measurements of bistatic radar cross section, Doppler frequency, backscattered cross-polarized signals, and distribution of scattered power by a radar interferometer. Comprehensive diagnostic measurements were made on the plasma so that the radar measurements could be compared to a proposed scattering model. Using the model, the radar cross section of the inhomogeneous plasma can be calculated for peak electron densities well beyond critical. The agreement between calculations and experiments is excellent. (auth)

42554 CALCULATIONS FOR AN EQUATORIAL F2-REGION SOLAR ECLIPSE. Sterling, D. L.; Hanson, W. B. (Univ. of Texas, Dallas). Radio Sci.; 5: 1029-39(Jul 1970).

The effects of a total solar eclipse on the equatorial F2 layer are studied by obtaining transient solutions of the time-dependent continuity equation. Electron concentrations for solar minimum conditions are calculated for two meridians that intersect the eclipse path, each at a different latitude. Inter-hemispherical coupling of ionization during an eclipse does not appreciably affect the electron concentrations. After maximum solar obscuration, an upward moving ionospheric layer develops below the F2 peak (on ionograms it appears as a cusp between f_0F1 and f_0F2 and is known as the eclipse $F_{1.5}$ layer), and it is explained in this paper in terms of electrodynamic drift. The assumed vertical component of drift is upward and approximately 14 m/sec at noon. The latitudinal extent of the eclipse $F_{1.5}$ layer is approximately ±10° magnetic latitude. Qualitatively there is good agreement between the calculations and equatorial ionospheric observations. The technique used by ionospheric observers for deducing the daytime electron production rate q and the linear loss coefficient β from eclipse data is applied to the calculated profiles to judge its efficiency in recovering these parameters. At 300 km, q is approximately 100 cm^{-3} sec^{-1} and β is approximately 1×10^{-4} sec^{-1}. If a drift of 14 m/sec is ignored, the calculated value of β at 300 km altitude is too large by approximately a factor of 3. (auth)

42555 D-REGION ELECTRON TEMPERATURES AT THE NORTHERN AURORAL ZONE. Lerfald, G. M.; Little, C. G. (ESSA Research Labs., Boulder, Colo). Radio Sci.; 5: 1017-28(Jul 1970).

To determine the approximate temperatures of free electrons in the sunlit ionospheric D region an experiment was conducted at a site near College, Alaska, during the summer and fall of 1960. A dual polarized antenna whose beam was directed at the zenith was used to observe alternately the incident radio noise fluxes in the ordinary and extraordinary polarizations at the frequency 2.89 MHz. The 2.89-MHz radio noise flux measured on a vertical dipole antenna was used to check for propagated interference from low elevation angles. The results show that, during the five-month observing period, the extraordinary-mode antenna registered a median daytime temperature of 260°K, with a standard deviation of about ±23°K, which indicates that the electrons in the D region are approximately in thermal equilibrium with the neutral gas, even at the auroral zones. The theoretically anticipated antenna temperatures, based on assumed ionospheric parameters, agree fairly well with the observed experimental values. In particular, the observed variations of antenna temperature with solar zenith angle can be matched by use of reasonable theoretical models. (auth)

42556 SOLAR WIND AND SOLAR ENERGETIC PARTICLES: PROPERTIES AND INTERACTIONS. Kavanagh, Lawrence D. Jr. (National Aeronautics and Space Administration, Washington, D. C.); Schardt, Alois W.; Roelof, Edmond C. Rev. Geophys. Space Phys.; 8: 389-460(May 1970).

Findings since 1966 are reviewed on the properties of the interplanetary magnetic field; the solar wind plasma; solar wind interactions with the Earth, the Moon, Mars, and Venus; and the properties and propagation characteristics of energetic solar-flare particles. For most purposes the solar wind can be characterized as a fluid that retains some of the properties of its source as it flows outward and that contains an anisotropic temperature distribution and embedded magnetic field. The magnetic field has a sector structure which slowly varies in a manner that resembles the evolution of magnetic features on the solar surface. As the solar wind encounters planetary bodies in its path, the nature of its interaction depends on the size and magnetic properties of the bodies. The solar wind creates a bow shock similar to that at Earth as it interacts with Venus, and probably also with Mars. At Venus the plasma is apparently not diverted by a magnetic field,

but by the planetary ionosphere. At Mars the plasma is diverted either by a weak magnetic field or by an ionosphere. Further studies near Earth have led to an explanation of the Earth's bow shock in terms of hydromagnetic and ion waves. Energetic electrons (>400 keV) have been found in the neutral sheet of the geomagnetotail. The absence of thermal plasma in the Earth's outer magnetosphere, beyond the plasmapause, has been explained in terms of a large-scale convection field. The solar-wind interaction with the Moon is of an entirely different character. No bow shock is found, and the interplanetary magnetic field appears to convect through the Moon. A single-particle model of the interaction appears adequate to explain the observed phenomena, including the region behind the Moon that is void of plasma but contains an enhanced magnetic field. Energetic electrons (20 keV to several MeV), protons (500 keV to 200 MeV), and α particles produced in solar flares have been studied in conjunction with solar x rays and radio bursts. It is now believed that these particles are not necessarily produced in an impulsive event during the flash phase of the flare; proton precursors have been found in some events, and it appears that energetic particles continue to leave the vicinity of the flare for hours or even days. These particles propagate preferentially along interplanetary magnetic field lines. Thus, their velocity distribution is generally anisotropic as long as the injection continues. (auth)

42557 SOME DATA ON THE NATURE OF THE RADIATION BACKGROUND AT ALTITUDES 250 TO 500 KM. Kurnosova, L. V.; Logacheva, V. I.; Rozarenov, L. A.; Sinitsina, V. G.; Fradkin, M. I.; Chukin, V. S. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 11: 143-5(20 Feb 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 229-33 (20 Feb 1970).

The satellite Kosmos-225 was provided with apparatus capable of separating electrons (on the basis of the intensity of the shower developing in lead radiators). The apparatus is diagrammed and the information transmitted is discussed. Results are given and the bunch hypothesis is considered. (W.D.M.)

42558 AIRCRAFT AIRGLOW INTENSITY MEASUREMENTS: VARIATIONS IN OH AND O I (5577). Dick, K. A.; Sivjee, G. G.; Crosswhite, H. M. (Johns Hopkins Univ., Baltimore). Planet. Space Sci.; 18: 887-94(Jun 1970).

Spectrophotometric airglow intensity measurements of OH Meinel (6,1), (7,2) bands, O I 6300 Å, hydrogen Hα and several O_2 Herzberg I bands were taken aboard NASA'S Convair 990 Airborne Laboratory during February and March 1968. In addition, O I 5577 Å and 6300 Å were monitored photometrically along the same line-of-sight. The results of a total of 28 hr under nonauroral conditions are presented, representing geographical variations from 10° North to 80° North latitude and local time variations from 1930 to 0430 hr. The OH, O I 5577 Å and O_2 features show a degree of covariation in intensity. An enhancement of the OH intensity near midnight was seen to be accompanied by a stronger correlation of OH with 5577 Å. After 0200 hr LT, daily and latitude fluctuations in the hydroxyl intensity tended to disappear, the intensity also becoming independent of 5577 Å. (auth) (UK)

42559 ENERGY TRANSFER FROM $N_2(A^3\Sigma_u^+)$ AS A SOURCE OF $O(^1S)$ IN THE AURORA. Parkinson, T. D. (Kitt Peak National Observatory, Tucson, Ariz.); Zipf, E. C. Planet. Space Sci.; 18: 895-900(Jun 1970).

Laboratory measurements have shown that deactivation of $N_2(A^3\Sigma_u^+)$ by ground state atomic oxygen often results in a metastable $O(^1S)$ atom. This source has been overlooked in discussions of the auroral green line. Rocket-borne photometer observations are discussed in light of this energy transfer source, but a number of established observational results cannot be accounted for by large contributions from this mechanism. (auth) (UK)

42560 F2-REGION DISTURBANCES ASSOCIATED WITH MAJOR MAGNETIC STORMS. Thomas, L. (SRC Radio and Space Research Station, Slough, Eng.). Planet. Space Sci.; 18: 917-28(Jun 1970).

The development of the disturbance in the F2-region during the magnetic storm of June 7, 1958 was studied in some detail using h_mF2 and N_mF2 data for a number of stations at middle and low latitudes. It was found that the most pronounced increases in layer height occurred during the development of the main phase of the magnetic storm, these increases taking place simultaneously over a latitude range greater than 70° in the American sector, and a longitude range of at least 100°. Simultaneous decreases in N_mF2 occurred over a wide range of longitudes, probably 360°, at middle latitudes. These changes indicate that the onset of the F2-region disturbance extended over a very wide area. The subsequent disturbance in N_mF2 at individual stations was dependent on the local time of onset of the disturbance, season, and latitude. In particular, the forms of the disturbance at a pair of magnetically conjugate stations were very different. Comparisons of N_mF2 data at this and other pairs of magnetically conjugate stations at middle latitudes have also shown that the F2-region effects of magnetic disturbances occurring during equinox periods can be very different at the ends of a tube of force. These results are discussed in terms of the importance of electrodynamic movements of ionization and the effects of atmospheric heating during magnetic storms. (auth) (UK)

42561 LOW-ENERGY GAMMA RADIATION IN THE ATMOSPHERE DURING ACTIVE AND QUIET PERIODS ON THE SUN. Chupp, E. L.; Forrest, D. J.; Sarkady, A. A.; Lavakare, P. J. (Univ. of New Hampshire, Durham). Planet. Space Sci.; 18: 939-43(Jun 1970).

The results from a series of five midlatitude balloon flights, covering the time period December 1966 to April 1968, are reported. The gamma-ray pulse-height spectra obtained in all balloon flights show clearly the evidence for line structure nominally at 0.5 MeV. Flux values are given for a 0.5-MeV line and it is assumed to be strictly annihilation radiation. A systematic study of the intensity of the 0.5-MeV line and the energy around 2.2 MeV was carried out. It is concluded that there is no evidence for solar-activity-associated enhancements for the 0.5- and 2.2-MeV gamma-ray lines. Using these null results, upper limits are placed on the solar flux of 0.5 MeV and the 2.2-MeV lines. The energy loss spectrum was measured over the energy range 0.2 to about 4 MeV, produced as a result of the gamma radiation at an average depth of about 4 g/cm^2 and at a geomagnetic latitude of about 41°N. (UK)

42562 ROCKET MEASUREMENTS SHOWING REMOVAL OF ELECTRONS ABOVE THE MESOPAUSE IN SUMMER AT HIGH LATITUDE. Pedersen, A. (European Space Research Lab., Noordwijk, Netherlands); Troim, J.; Kane, J. A. Planet. Space Sci.; 18: 945-8(Jun 1970).

A Nike–Apache rocket was launched during an auroral absorption event at Andoya in Norway (geomagnetic latitude 67.5°N) at 22.47 hr LT on 26 June 1966. The absorption was 2.5 db. Observations of electron removal and associated changes of positive ions near 87 km, as observed by a Faraday rotation experiment for measurement of electron density and a positive ion probe, are reported. The probe experiment was to study wake effects rather than to determine ion density. Possible explanations of the shift of the wake and the electron density minimum are considered. (UK)

42563 IONOSPHERIC PLASMA DISTURBANCES DUE TO A MOVING SPACE VEHICLE. Oya, Hiroshi (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci.; 18: 793-802 (Jun 1970).

Disturbances due to a moving space vehicle in the ionospheric plasma were investigated by means of accurate measurements of the electron density in rarefied wake regions, using a gyro-plasma probe. The vehicle wake structure of the K-9M-21 rocket in the ionosphere can be measured on its descent and was investigated theoretically on the basis of the hydrodynamics of a quasi-neutral plasma. It is confirmed that the ionospheric plasma can be treated as a neutral gas for analysis of the vehicle wake by neglecting the effect of the local first-order electric field and the ambient geomagnetic field. The disturbance-free region which is important for the measurement of the undisturbed ambient plasma density is also discriminated clearly from the wake region surrounding the moving space vehicle. (auth) (UK)

42564 GEOCORONAL HYDROGEN: AN ANALYSIS OF THE LYMAN-ALPHA AIRGLOW OBSERVED FROM OGO-4. Meier, R. R.; Mange, P. (Naval Research Lab., Washington, D. C.). Planet. Space Sci.; 18: 803-21(Jun 1970).

Observations of the hydrogen Lyman-alpha glow, surrounding the Earth, were carried out from the OGO-4 spacecraft. The dependence of this emission feature on solar zenith angle was measured in the altitude range of about 400 to 900 km. The Lyman-alpha is attributed to radiative transport of solar Lyman-alpha photons through the hydrogen geocorona. The data are analyzed by solving the spherical radiative transport problem for selected hydrogen models. The principal features of the observations can be explained by a combination of the models of Kockarts and Nicolet (1963) and Chamberlain (1963) normalized to 3×10^7 hydrogen atoms per cm^{-3} at 100 km for the Fall, 1967 epoch. This implies an optical depth of 1.33 above 650 km. Theory and observation establish an upper limit of a factor of four for the diurnal variation of the hydrogen concentration at high altitude. (auth) (UK)

42565 MEASUREMENTS OF THE ELECTRIC FIELD COMPONENT OF WAVES IN THE AURORAL IONOSPHERE. Kelley,

M. C. (Univ. of California, Berkeley); Mozer, F. S.; Fahleson, U. V. Planet. Space Sci.; 18: 847-65(Jun 1970).

Electric field components of waves with frequencies below about 1000 Hz were measured with double Langmuir probe electric field detectors on three rockets flown into the auroral ionosphere. The operation of these detectors was analyzed with the conclusion that spurious noise sources can be controlled and electric fields with amplitudes as small as a few microvolts/meter (Hertz)$^{\frac{1}{2}}$ can be measured. Evidence that alternating electric fields were measured is presented from analyses of signal amplitudes and correlations between pairs of independent antennas of different sizes on the same rocket, from correlation of signal variations with other geophysical phenomena, and from the spin modulation of the detected signal. Power spectra and cross-correlation coefficients from a flight near local midnight into an auroral display are presented and it is concluded that ion-acoustic waves generated near the boundaries of auroral arcs were probably detected. The wave amplitudes are sufficiently large to suggest that wave-particle interactions and turbulence play important roles in the auroral ionosphere. (auth) (UK)

42566 ELF AND VLF PROPAGATION FOR MODELS OF A PERTURBED IONOSPHERE. Galejs, Janis (Sylvania Electronics Systems, Waltham, Mass.). Radio Sci.: 5: 1041-4(Jul 1970).

Calculated parameters of wave propagation illustrate the effects of various choices of ion collision frequencies and molecular weights. Comparisons with atmospheric conductivity measurements tend to justify the use of ion collision frequencies that exceed the collision frequency between neutral particles and of molecular weights that are larger than the molecular weights for the usually assumed atmospheric constituents. (auth)

42567 ELECTRIC FIELD OBSERVATIONS OF IONOSPHERIC WHISTLERS. Maynard, N. C.; Aggson, T. L.; Heppner, J. P. (Goddard Space Flight Center, Greenbelt, Md.). Radio Sci.: 5: 1049-58(Jul 1970).

A Nike-Tomahawk sounding rocket was launched near local noon on November 8, 1966, from Wallops Island with a triaxial electric field experiment using long cylindrical dipoles for sensors. Twenty elf whistlers with dispersion constants ranging from 0.15 to 0.85 sec$^{\frac{1}{2}}$ were detected and identified as having propagated up to the rocket through the E region from the earth-ionosphere waveguide. The data extend to the smallest dispersion ever encountered and the lowest frequencies observed on ionospheric whistlers (60 Hz). The waves were elliptically polarized, becoming more nearly circular at higher altitudes. Analysis showed good agreement between the experimental results and quasi-longitudinal (QL) propagation theory for amplitude, dispersion, and polarization characteristics of the wave once it is away from the D- to E-region boundary. No appreciable effects of negative ions or protons were observed in the dispersion of the whistlers. (auth)

42568 RELATIONS BETWEEN THE SPORADIC E-LAYER AND GEOMAGNETIC DISTURBANCES IN THE NORTHERN AURORAL AND POLAR REGIONS. Tauer, Jaroslav (Geophysical Inst., Prague). Stud. Geophys. Geod.; 14: 325-35 (1970).

Ionospheric vertical sounding data for 12:00 GMT and geomagnetic data in terms of hourly mean values, centered at 11:30 GMT, covering the whole of the IGY, recorded at 29 ionospheric and 11 geomagnetic stations, were treated statistically. A survey of the basic statistical data is given and shows the percentage of occurrence of sporadic E with a critical frequency up to, equal to, or over 5 Mc/sec, of partial and total blackout. (M.O.W.)

42569 PARTICLES AND FIELDS IN THE MAGNETOSPHERE. Proceedings of a Symposium Held at Santa Barbara, California, August 4-15, 1969. McCormac, B. M. (ed.). Astrophysics and Space Science Library. Volume 17. New York; Springer-Verlag New York Inc. (1970). 463p. $27.00. (CONF-690836).

Separate abstracts were prepared for 39 papers presented on magnetospheric models, the bow shock, magnetospheric particles, magnetic and electric fields in the magnetosphere, wave-particle interactions, radiation belt observations, and acceleration and motion of particles. A summary includes a panel report, conclusions, and a glossary. (J.C.W.)

For abstracts of individual papers see: 42467, 42468, and 42570-42606.

42570 ENTRY OF SOLAR COSMIC RAYS INTO THE EARTH'S MAGNETOSPHERE. Anderson, K. A. (Univ. of California, Berkeley). pp 3-17 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Theoretical and experimental phenomena are presented concerning the flowing of the solar wind past the magnetosphere. The possibilities of a closed or open magnetosphere are discussed. It has been reported that the energy spectra of solar protons and electrons when measured simultaneously inside and outside the magnetosphere are closely the same. These observations provide important and independent evidence that both species of particles have entered the magnetosphere on smoothly connected field lines. It seems highly unlikely that the energy of these particles could remain constant if it were hypothesized that they were diffused into a closed magnetosphere. It has been assumed that if an interplanetary field line has connected to a magnetotail line, solar particles will follow this new configuration into the magnetosphere. (J.C.W.)

42571 FORMATION AND GEOMETRY OF GEOMAGNETIC TAIL. Dessler, A. J. (Rice Univ., Houston, Tex.). pp 18-23 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Postulations on the magnetic merging processes and their influence on the magnetosphere and the influence of field-aligned currents (Birkeland currents) to magnetosphere phenomena are discussed. Theoretical and experimental data on the formation, cross section, and length of the magnetotail, and the mechanism of auroral bombardment are presented. (J.C.W.)

42572 MAGNETOTAIL PLASMA AND MAGNETOSPHERIC SUBSTORMS. Hones, Edward W. Jr. (Los Alamos Scientific Lab., N. Mex.). pp 24-33 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Energy spectral measurements of electrons and protons between ~100 eV and ~20 keV and measurements of electrons with energies above several higher thresholds from ~40 keV to several hundred keV were made by instrumentation aboard Vela 3A and 4A as they passed through the magnetotail. Results are given on the plasma-sheet time variations during magnetosphere substorms and the observations made of the pressure of the magnetotail plasma as related to the dynamic pressure of the solar wind. (J.C.W.)

42573 MODEL CURRENT SYSTEM FOR THE MAGNETOSPHERIC SUBSTORM. Akasofu, S.-I. (Univ. of Alaska, College). pp 34-45 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

A model three-dimensional current system for the magnetospheric substorm is proposed to account for the distribution of geomagnetic disturbance field vectors on the Earth's surface and for the distribution of auroral electrons and protons at the ionospheric level and in the equatorial plane. It is suggested that the asymmetric ring current completes its circuit by accelerating auroral particles and by driving the auroral electrojet. (auth)

42574 ORIGIN OF RADIATION BELT AND AURORAL PRIMARY IONS. Axford, W. I. (Univ. of California, San Diego, La Jolla). pp 46-59 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

The possibilities that the energetic ions in the radiation belts and in the auroral primaries might originate in the ionosphere or in the solar wind are examined. It is argued that there is no clear evidence favoring one source over the other on the basis of the observations that have been carried out to date. An entirely different type of observation is proposed as a means of providing a cheap and effective way of deciding this question and of providing information concerning the rate of accretion of inert gases by the atmosphere. (auth)

42575 MATHEMATICAL MODELS OF MAGNETOSPHERIC CONVECTION AND ITS COUPLING TO THE IONOSPHERE. Vasyliunas, Vytenis M. (Massachusetts Inst. of Tech., Cambridge). pp 60-71 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

A simple model of magnetospheric convection was constructed, postulating a primary flow away from the Sun over the polar cap

and considering only the effects of the ionosphere. With the inclusion of an enhanced conductivity region at the auroral zones, the model predicts the observed location of the plasmasphere bulge and, with the assumption that equivalent currents constructed from magnetic disturbances primarily reflect the source-free component of the ionospheric current, it reproduces the main features of the DS current system, including the westward tilt over the polar cap. (J.C.W.)

42576 SOLAR WIND STIMULATION OF THE MAGNETOSPHERE. Bame, S. J. (Los Alamos Scientific Lab., N. Mex.). pp 75-8 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Time variations in solar wind parameters were studied to investigate their responsibility for geomagnetic activity in the magnetosphere. Comparisons were made of 3 hr-average values of solar wind parameters and their deviations for periods of low and high geomagnetic activity obtained from satellite measurements. (J.C.W.)

42577 PLASMA MEASUREMENTS NEAR THE EARTH'S BOW SHOCK: VELA 4. Montgomery, Michael D. (Los Alamos Scientific Lab., N. Mex.). pp 95-101 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Evidence that electron preheating occurs in the bow shock is presented. The resulting enhancement of the electron–ion temperature ratio T_e/T_i may be sufficient to destabilize the electrostatic waves observed previously. Evidence for the possible strong interaction of the ion velocity distribution with these waves, resulting in strong ion heating, is also included. A possible mechanism for fast preheating of the electrons may be the Buneman (1959) instability (Kennel, 1970) driven by large electron drift speeds. The possible existence of electron drift speeds greater than the electron thermal speed is indicated by the steepness of the magnetic field gradient within the shock. (J.C.W.)

42578 AC ELECTRIC AND MAGNETIC FIELDS AND COLLISIONLESS SHOCK STRUCTURES. Scarf, F. L.; Fredricks, R. W.; Kennel, C. F. (TRW Systems Group, Redondo Beach, Calif.). pp 102-8 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Instruments on board Pioneer 8 and 9 and OGO 5 provided high-time-resolution plasma diagnostics from which the gross and fine structure of collision-free shocks could be deduced. Several types of shock structures have been found in the high beta ($\beta \approx 1$) high Mach number ($M_A \approx 10$) flows of solar wind plasma impinging upon the magnetospheric obstacle and in the low-Mach-number interplanetary shocks. By far the most common structure is a large-amplitude MHD pulse structure having a characteristic length of the initial gradient and trailing wavetrain corresponding to a few times c/ω_{pe}, the electron inertial length. The dissipation mechanism in such shock structures is provided by electrostatic wave turbulence arising apparently from current-driven electron–proton or proton–proton two-stream instabilities that saturate nonlinearly. Nonlinear whistler-mode waves also occur in some shock structures, but provide much less efficient dissipation or proton thermalization compared with that due to the electrostatic turbulence. (auth)

42579 ENERGETIC PARTICLE PHENOMENA IN THE EARTH'S MAGNETOSPHERIC TAIL. Van Allen, James A. (Univ. of Iowa, Iowa City). pp 111-21 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Solar electrons of kinetic energy ≥50 keV were used as test particles to study the gross magnetic topology of the Earth's distant magnetospheric tail and electric fields therein. The observations were made with similar systems of detectors on the Earth-orbiting Explorer 33 and the Moon-orbiting Explorer 35. Based on study of electron shadowing by the moon, of the simultaneous intensity of solar electrons in interplanetary space and within the magnetotail, and of the very short time delay in access of impulsively emitted solar electrons into the magnetotail, conclusions proposed are: (1) the gross magnetic topology of the distant magnetotail is an open one (i.e., dynamic interconnection of geomagnetic field lines to those in the interplanetary medium); (2) there are no closed electrical equipotential surfaces in the magnetotail at downstream distances greater than 64 R_E; (3) solar electrons enter the magnetotail at downstream distances between 64 and 900 R_E; and (4) support is given to the idea that the motional electromotive force caused by the motion of the interplanetary magnetic field past the Earth is responsible for driving magnetospheric plasma convection and electrical currents in the polar ionosphere. (auth)

42580 ANISOTROPIC DISTRIBUTIONS OF ENERGETIC ELECTRONS IN THE EARTH'S MAGNETOTAIL AND MAGNETOSHEATH. Singer, S.; Bame, S. J. (Los Alamos Scientific Lab., N. Mex.). pp 122-31 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Results are given of an analysis of 6 months of data from instruments aboard Vela 4 satellites in which the observations of electron isotropies are extended to ~18.5 R_E and to high (60°) ecliptic latitudes. Streaming energetic electrons are unambiguously detected in the magnetosheath not far from the magnetopause. Spatial distribution shows that they are not necessarily found close to the solar magnetospheric equatorial plane, and have never been observed inside the magnetopause. The streaming direction is usually antisolar and often approximately parallel to the magnetopause. Large directional anisotropies in plasma-sheet energetic electrons were detected that do not arise from streaming but from symmetric anisotropic pitch-angle distributions. Spatial distribution of these occurrences shows that they are never seen outside the magnetopause, and that they are far more likely to be seen at magnetospheric longitudes near ~240° than at other locations. Anisotropic distributions are seldom seen near the midnight meridian although isotropic energetic electrons are frequently detected there. Near the neutral sheet, the directional anisotropies seem to be consistent only with nearly vertical magnetic field and with particle pitch angles that peak near 90°. (J.C.W.)

42581 TRAPPED AND POLAR PARTICLES DURING THE JUNE 9, 1968 MAGNETIC STORM. Rothwell, P. L.; Webb, V. H.; Katz, L. (Air Force Cambridge Research Labs., Bedford, Mass.). pp 132-40 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

During June 7 to 26, 1968, simultaneous observations of protons and electrons (0.1 to 1.0 MeV) were made. The proton fluxes were consistent with radial diffusion, conserving the first two adiabatic invariants. However, the electron fluxes showed a preferential hardening around L = 4.0, consistent with a weak acceleration mechanism. The presence of both electrons and protons outside the trapping boundary was observed for LT = 2100 h. Pitch-angle distributions are presented. (auth)

42582 SOLAR PARTICLE OBSERVATIONS OVER THE POLAR CAPS. Paulikas, G. A.; Blake, J. B.; Vampola, A. L. (Aerospace Corp., El Segundo, Calif.). pp 141-7 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Recent results of measurements of solar-particle spatial (latitude) distributions and angular distributions are summarized. Solar proton and electron data are compared, and the relation between the limits of trapping and the access and cutoff latitudes for solar particles is discussed. The data were obtained aboard the USAF–OAR satellites OV3–3, OV1–12, and OV1–15. (J.C.W.)

42583 REACTION OF THE PLASMAPAUSE TO VARYING MAGNETIC ACTIVITY. Chappell, C. R.; Harris, K. K.; Sharp, G. W. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). pp 148-53 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Concentrations of H^+, He^+, and O^+ ions were measured from an initial perigee height of ~300 km to an apogee of ~23 R_E by the light ion mass spectrometer aboard OGO 5. The ion concentrations were measured within the plasmasphere, through the plasmapause and trough region of the outer magnetosphere. In examining the relation between magnetic activity, as given by the K_p index, and the location of the plasmapause, it is found that there exists a fair

correlation between an increase in the activity and a decrease in the plasmapause position within ±2 hr of 1000 and of 0200 LT. (J.C.W.)

42584 MAGNETIC FIELDS IN THE EARTH'S TAIL. Behannon, Kenneth W. (Goddard Space Flight Center, Greenbelt, Md.). pp 157-64 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Initial mapping of the magnetic field in the geomagnetic tail out to a distance of 31 R_E by IMP I established the basic structure of the tail. In addition to the generally steady well-collimated nature of the field in the tail, a radius of approximately 20 R_E out to a geocentric distance of 30 R_E in the antisolar direction was deduced and the existence of a relatively thin ($\leq R_E$) neutral sheet separating directly opposite fields was established. Deductions made from satellite measurement, data, and observations are summarized. Divergence of the magnetotail field, location of the neutral line, and aberration and length of the magnetotail are discussed. (J.C.W.)

42585 MAGNETIC FIELD OBSERVATIONS IN HIGH β REGIONS OF THE MAGNETOSPHERE. Sugiura, M.; Skillman, T. L.; Ledley, B. G.; Heppner, J. P. (Goddard Space Flight Center, Greenbelt, Md.). pp 165-70 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

A discussion of the distortion of the geomagnetic field in the magnetosphere is given on the basis of magnetic observations by OGO 1, 3, and 5 satellites. Approximate distributions of $\Delta\beta$ (the magnitude of the measured field minus the magnitude of the reference field) are given in the noon and midnight sectors of the magnetosphere for magnetically quiet ($K_p = 0$ or 1) and slightly disturbed ($K_p = 2$ or 3) conditions. The field depression in the region of $L \gtrsim 6$ caused by the quiet-time ring current is shown to increase even during weak disturbances. A sudden decrease in the magnetic field followed by irregular variations was often observed near midnight on low-latitude inbound orbits. Following the onset of a negative bay disturbance on the ground the magnetic field in the tail collapses near the meridional plane of the bay onset. On the dawn side of the magnetosphere the magnetic field gradient is near zero in the equatorial region between about 11 R_E and the magnetopause. (J.C.W.)

42586 FLUCTUATIONS IN THE DISTANT GEOMAGNETIC FIELD DURING SUBSTORMS: ATS 1. Coleman, Paul J. Jr.; McPherron, Robert L. (Univ. of California, Los Angeles). pp 171-94 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

A review is given of the observations made of the variations in the magnetic field in the synchronous orbit that are characteristic of substorms. ATS 1 was launched into the equatorial orbit on December 6, 1966, and is spin stabilized at a nominal rotation frequency of 1.67 Hz. Results of the satellite data are summarized. (J.C.W.)

42587 AC MAGNETIC FIELDS. Russell, Christopher T.; Holzer, Robert E. (Univ. of California, Los Angeles). pp 195-212 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Magnetic fluctuations were observed by ground observatories from the Pc5 band to the vlf band. Not all these fluctuations were observed also in space, however. The precision of satellite-borne instruments, data rates, and orbital characteristics restricted observations in the past, so that only the lowest and the highest frequencies were examined extensively. Preliminary results from recent experiments are presented together with a review of past work. These latest results suggest first, that the large-amplitude 100- to 300-sec period waves are field line resonances driven by waves generated by the motion of the magnetopause and second, that elf hiss and chorus are the results of a plasma instability in the equatorial region of the magnetosphere. (auth)

42588 ELECTRIC FIELDS IN THE IONOSPHERE AND MAGNETOSPHERE. Haerendel, G.; Luest, R. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). pp 213-28 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

A brief synopsis is given of ion cloud experiments in the auroral zones from the point of view of magnetospheric convection. The extrapolation of the observed ionospheric motions or fields to the magnetosphere usually involves the assumption of infinite conductivity and of the magnetic field remaining undistorted under the convective motions of the magnetospheric plasma. Preliminary results of the first ion cloud experiment in the distant magnetosphere are discussed. (J.C.W.)

42589 AURORAL AND POLAR CAP ELECTRIC FIELDS FROM BARIUM RELEASES. Wescott, Eugene M.; Stolarik, John D.; Heppner, James P. (Goddard Space Flight Center, Greenbelt, Md.). pp 229-38 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Barium release experiments were performed in the ionospheric auroral and polar cap regions to determine the nature of the electric fields and the tensor conductivity elements that are most effective in producing ionospheric currents. The four regions sampled were in the westward electrojet or negative magnetic bay region, the eastward electrojet region, the transition region where the westward electrojet passes polewards of the eastward jet, and the polar cap region. (J.C.W.)

42590 SATELLITE MEASUREMENTS OF DC ELECTRIC FIELDS IN THE IONOSPHERE. Gurnett, Donald A. (Univ. of Iowa, Iowa City). pp 239-46 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Initial results are presented from the dc electric field experiment on the low-altitude polar-orbiting Injun 5 satellite. At low latitudes, where the ionospheric plasma is expected to corotate with the earth, the only observed electric field is the $V \times B$ electric field due to the motion of the satellite through the ionosphere. Comparisons of the computed $V \times B$ field agree with the measured electric field within about ±10 mV/m. At the plasmapause boundary, small changes (~5 to 15 mV/m) in the dc electric field are observed which are believed to be due to magnetospheric convection phenomena at the plasmapause boundary. At high latitudes, large-amplitude (~100 mV/m) electric field irregularities and disturbances, believed to be due to ionospheric electric fields, are observed on virtually every passage over the polar regions. Long-period electric field oscillations with periods on the order of 15 sec also are commonly observed at high latitudes. (auth)

42591 VARIATIONS IN ELECTRIC FIELDS FROM POLAR-ORBITING SATELLITES. Maynard, N. C.; Heppner, J. P. (Goddard Space Flight Center, Greenbelt, Md.). pp 247-53 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

The probe technique was used to measure electric fields from dc to low vlf frequencies on both OV1 10 and OGO 6. OV1 10, launched in Dec. 1966 (648 by 776 km orbit with a 93.4° inclination) had 51 ft antennas aligned along the local vertical for use in the gravity gradient stabilization of the satellite. OGO 6 was launched in June 1969 into an elliptical polar orbit (400 to 1600 km with an inclination of 82°). Characteristics of the electric fields deduced from OV1 10 measurements using the preliminary data of the recently launched OGO 6 substantiates the OV1 10 data on spatial irregularities and waves in the elf-vlf regime. (J.C.W.)

42592 HIGH-FREQUENCY ELECTROSTATIC WAVES IN THE MAGNETOSPHERE. Kennel, C. F. (Univ. of California, Los Angeles); Fredricks, R. W.; Scarf, F. L. pp 257-65 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Several theories of high-frequency electrostatic instabilities are reviewed, and examples of relevant OGO 5 observations are presented. (auth)

42593 MUTUALLY INTERACTING INSTABILITIES IN THE MAGNETOSPHERE. Cornwall, John M. (Univ. of California, Los Angeles. Aerospace Corp., El Segundo, Calif.). pp 265-74 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

The interaction of instabilities in the magnetosphere is discussed and a specific example concerns an Alfvén drift mode in an auroral

plasma which is subject to an unspecified high-frequency instability that causes pitch-angle diffusion of the plasma. The influence of the high-frequency instability of the drift-wave growth rate, in terms of the pitch-angle diffusion coefficient, is calculated. General aspects of the equilibrium problem are described briefly. (J.C.W.)

42594 AC FIELDS AND WAVE–PARTICLE INTERACTIONS. Scarf, F. L.; Kennel, C. F.; Fredricks, R. W.; Green, I. M.; Crook, G. M. (TRW Systems Group, Redondo Beach, Calif.). pp 275-83 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Several new experiments provide detailed information about electrostatic and electromagnetic plasma waves in the outer magnetosphere, magnetosheath, and solar wind. Dipole antennas now commonly detect the electric components of whistler mode chorus and triggered emissions near 20 to 50% of the local or equatorial gyrofrequency, and purely electrostatic bursts are sometimes found in the same frequency range. Nonwhistler mode electrostatic noise with $f > f_c$(local) is very frequently detected on the nightside auroral lines of force, and strong emissions that appear to be related to the Bernstein modes are found beyond the plasmapause very near the magnetic equator. These electrostatic signals, as well as the chorus bursts, represent strong sources of turbulence that can produce significant pitch-angle scattering, particle precipitation, and acceleration. On Pioneer 8 and 9, low-frequency electrostatic waves are found near the nightside magnetopause boundary; these signals may be associated with fast diffusion and with the "viscous" interaction that produces the geomagnetic tail. In the magnetosheath and solar wind other types of wave–particle interactions are observed. Magnetic "null" regions at filament boundaries generally involve excitation of intense high-frequency electrostatic noise and locally trapped electromagnetic waves are sometimes detected in density troughs. The modern comprehensive payloads allow some wave modes to be identified completely and in-orbit verification of the E field amplitude measurements is obtained. (auth)

42595 HYDROMAGNETIC WAVES AND INSTABILITIES IN THE MAGNETOSPHERE. Hasegawa, A. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 284-91 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

A brief review of hydromagnetic waves and instabilities with an example of actual observation of such an instability in the magnetosphere is presented. Existence of cold electrons in the magnetosphere is pointed out to modify the known dispersion relations of the hydromagnetic waves because they short circuit the parallel electric field. Among the velocity space instabilities introduced, the mirror instability and the current driven transverse instability seem to be most feasible in the magnetosphere. The latter instability shows a frequency of instability proportional to difference in charge density along the line of force, or the relatively low threshold current. Finally, saturation of diamagnetization and anisotropization and succeeding oscillations of proton fluxes during a storm time of April 18, 1965, are explained in the context of the mirror instability. (J.C.W.)

42596 INTENSITY OF DISCRETE VLF EMISSIONS. Helliwell, R. A. (Stanford Univ., Calif.). pp 292-301 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

A phenomenological theory of discrete emissions based on cyclotron resonance between energetic electrons and narrow-band whistler-mode waves traveling along the static magnetic field has been advanced (Helliwell, 1967). A feature of the theory is the maintenance of oscillations through feedback between the waves and the electrons over a path long compared with the wavelength. The theory is extended to include a general electron density model and variable-frequency waves. The length of the resonance region is calculated for a representative model of the magnetosphere. This length is then used to estimate the magnetic field intensity of the emission. (J.C.W.)

42597 SUMMARY OF PARTICLE POPULATIONS IN THE MAGNETOSPHERE. Vette, James I. (Goddard Space Flight Center, Greenbelt, Md.). pp 305-18 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

The charged-particle distribution within the three basic regions of the magnetosphere is discussed. Data from satellite observations on the plasma sheet, pseudo-trapping, and stable-trapping regions are given and particle fluxes are characterized. The regions of the magnetosphere in the equatorial plane are depicted when magnetic activity is not very high. (J.C.W.)

42598 FURTHER COMMENTS CONCERNING LOW-ENERGY CHARGED-PARTICLE DISTRIBUTIONS WITHIN THE EARTH'S MAGNETOSPHERE AND ITS ENVIRONS. Frank, L. A. (Univ. of Iowa, Iowa City). pp 319-31 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Several recent observations of the distributions of low-energy charged particles ($100\ \text{eV} \lesssim E \lesssim 50\ \text{keV}$) within the Earth's magnetosphere and its environs are examined for evidences of source (acceleration) mechanisms. Proton ($0.5\ \text{keV} \lesssim E \lesssim 50\ \text{keV}$) intensities in the outer radiation zone and plasma sheet are concentrated upon since this population forms the largest charged-particle energy reservoir in the magnetospheric system. To date no source mechanism for these proton intensities with broad differential energy spectrums (i.e., of the plasma sheet and the storm time and quiescent ring currents) has been delineated clearly. It is suggested herein that at least the storm-time ring-current protons are of solar origin and are convected into the magnetotail under the influence of magnetospheric electrostatic fields or via a diffusion process driven by fluctuating magnetic and/or electric fields. (auth)

42599 ORIGIN AND DISTRIBUTION OF ENERGETIC ELECTRONS IN THE VAN ALLEN RADIATION BELTS. Winckler, J. R. (Univ. of Minnesota, Minneapolis). pp 332-52 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

New results on the injection and distribution of the energetic electron component of the trapped radiation as a result of magnetic storms are discussed. The results were obtained with magnetic-deflection electron spectrometers carried in the OGO 1 and 3 satellites in elliptical orbits penetrating both the inner and outer zone regions and in the ATS 1 geostationary orbit satellite in the outer zone. The energy range extends from about 50 keV to several MeV and the variations of the directional flux with pitch angle, energy, and position in the trapping regions were studied. (J.C.W.)

42600 RECENT MEASUREMENTS OF INNER-BELT PROTONS. Elliot, H.; Hynds, R. J. (Imperial Coll. of Science and Tech., London). pp 353-63 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Measurements made in the inner radiation belts from the satellite ARIEL 1 and from Explorer 4 were compared and it was concluded that the proton flux had not increased between 1959 and 1962 but, if anything, had decreased. The result was shown to be consistent with the solar-cycle intensity variation predicted by Blanchard and Hess. The intensity variation measurements concerned protons with $E \geq 30$ MeV over the solar cycle. A magnetic storm event on Oct. 31, 1968, was observed in which high-energy proton precipitation appeared at the equatorial inner radiation belt. The event was observed from balloon flights carried out from Kampala, Uganda. (J.C.W.)

42601 ALPHA PARTICLES TRAPPED IN THE EARTH'S MAGNETIC FIELD. Krimigis, S. M. (Johns Hopkins Univ., Silver Spring, Md.). pp 364-79 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

A summary is given of previous attempts to identify alpha particles in the radiation zones. Recent data obtained with the satellite Injun 5 presents some advantages over previous data which include positive particle identification, lower detector energy threshold (to ~1 MeV), determination of spectral form, and faster time resolution. Present preliminary results and previous data show that the alpha particle-to-proton ratio is highly variable at low energies ($E \lesssim 0.5$ MeV/nucleon), but that it appears to be relatively constant at higher energies over a period of approximately 4 yr. The disagreement between ob-

servations and the diffusion from the solar wind model remains unresolved. (J.C.W.)

42602 MEASUREMENTS OF TRAPPED α PARTICLES: $2 \leq L \leq 4.5$. Blake, J. B.; Paulikas, G. A. (Aerospace Corp., Los Angeles). pp 380-4 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Measurements of the fluxes and energy spectra of trapped alpha particles have continued because the measurements give clues to the source and loss mechanisms of the more-abundant protons. Data from instruments flown aboard satellite 1968-26B were taken from April 4 to 7, 1968. The predictions of Tverskoi (1965) which include only Coulomb loss are compared with the experimental data and the comparison is inconclusive as to whether particles are injected into the magnetosphere with the same velocity, the same energy, or neither. Previous data concerning proton fluxes and ratios to alpha particles are presented. (J.C.W.)

42603 INTRODUCTORY SURVEY OF RADIATION-BELT DIFFUSION. Faelthammar, Carl-Gunne (Royal Inst. of Tech., Stockholm). pp 387-95 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

A summary of observational data which confirms that radial diffusion affects radiation belt dynamics is given. The most direct indications come from observations of time variations of flux profiles. A compilation of these results shows that the flux distribution is deformed during its motion and the velocity is not well defined and different parts of it (maxima, inflection points, etc.) appear to move at different velocities. Diffusion coefficients have been calculated. The presence of radial diffusion has also been inferred from analysis of observed equilibrium states and such considerations were first applied to the outer zone soft protons, whose stable fluxes were suggestive of diffusive equilibrium. Recently, equilibrium analyses have been applied for electrons. Computing diffusion coefficients for outer-belt electrons is difficult. The rapid access of solar protons to the interior of the magnetosphere was observed by Lanzerotti (1968) and is interpreted as being due to rapid diffusion across magnetic field lines. McDiarmid and Burrows (1967) observed a solar-cycle variation of the position of energetic electrons in qualitative agreement with diffusion from an external source. (J.C.W.)

42604 TRAPPED PROTONS $\geq$100 keV AND POSSIBLE SOURCES. Williams, D. J. (Goddard Space Flight Center, Greenbelt, Md.). pp 396-409 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

The general characteristics of trapped $\geq$100-keV protons, the principal time variations observed, and the status of major source and transport mechanism are discussed, with emphasis on diffusion by violation of the third adiabatic invariant. The early indications and additional observations of lower-energy protons in the trapping regions are discussed from satellite data. Data from January to June, 1965, were used by Soraas and Davis to study the temporal variations of the trapped 100- to 1700-keV proton population. It appears that diffusion theory employing violation of the third adiabatic invariant and conservation of the first and second invariants predicts distribution functions that are in good agreement with the observed steady-state proton distribution and the observed time evolution of the proton distribution during the slow nonadiabatic recovery toward pre-storm intensity following a magnetic storm. (J.C.W.)

42605 RADIAL DIFFUSION OF TRAPPED PARTICLES. Walt, Martin (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). pp 410-15 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

A brief review of the theoretical formulation underlying the analysis of radial diffusion of trapped particles is given. The theory provides for the inclusion of the energy spectrum, pitch-angle distribution, and radial variation of the flux, all as a function of time. If only part of the information is known, and other factors are assumed, the definiteness of the calculation is lost. (J.C.W.)

42606 BALANCE BETWEEN RADIAL AND PITCH-ANGLE DIFFUSION. Haerendel, G. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). pp 416-28 of Particles and Fields in the Magnetosphere. /McCormac, B. M. (ed.). New York; Springer-Verlag New York Inc. (1970).

From Symposium on Particles and Fields in the Magnetosphere, Santa Barbara, Calif. See CONF-690836.

Equations are given that attempt to describe the observed populations of trapped particles in the radiation zones and express conservation of particle number and energy and conservation of electromagnetic wave energy. Similar equations are the basis of the quasi-linear theory of trapped radiation. Model distributions of proton fluxes in the outer radiation belt were derived from the application of the theory of pitch-angle instability. Data showing the presence of either pitch-angle scattering or transport across L shells have been accumulated. Situations involving protons seem less complex and are, therefore, being considered here. A brief summary of wave-particle interaction is given. (J.C.W.)

Low-Temperature Physics

42607 (JUL-647-FN) CHANGES OF THE MAGNETIC PROPERTIES OF SUPERCONDUCTING NIOBIUM BY ELECTRON IRRADIATION AT 4.5°K. Papastaikoudis, Constantin (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerper- und Neutronenphysik). Mar 1970. 58p. (In German). Dep. CFSTI (U. S. Sales Only).

The type-II superconductor Nb was irradiated at a temperature of 4.5°K with electrons at an energy of 3 MeV. The magnetization curve and the resistance were measured as a function of the irradiation dose and as a function of the temperature after isochronous recovery. The upper critical field H_{c2} and the residual resistance was determined from each measurement. In the irradiation the upper critical field H_{c2} shows a linear dependence on the residual resistance; on the other hand during the isochronous recovery the dependence of the resistance has a structure which is in direct relation with the recovery stage of the Nb. This result confirms qualitatively a theory of Eilenberg that says the upper critical field H_{c2} depends not only on the free path length of the electrons but also on the anisotropy of the scattering of the electron waves on the defects. The magnetization curve, taken during the irradiation, shows a hysteresis in contrast to unirradiated samples. The hysteresis is traceable to the anchoring force that originates from the statistically distributed interstitial atoms and vacancies. (tr-auth)

42608 (LNF-69/28) STATISTICAL APPROACH TO THE SPIN REFRIGERATOR. Note No. 443. Montelatici, V. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 22 Apr 1969. 26p. Dep. CFSTI (U. S. Sales Only).

Topics covered include: spin temperature and chemical potentials; thermal mixing of two interacting spin systems; conditions on the spin-lattice relaxation times to obtain positive and negative spin temperatures; an experiment to detect positive, negative, and infinite spin temperatures; condition on the cross relaxation time at the temperature of mixing; and a qualitative discussion of the spin refrigerator. (W.D.M.)

42609 (LNF-70/5) SUPERCONDUCTIVITY IN ELECTRICAL ENGINEERING. Note No. 464. Sacerdoti, G. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 4 Mar 1970. 64p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The preparation of superconductors for high field magnets is discussed with emphasis on the preparation of Nb_3Sn, NbTi, NbZr, and V_3Ga. The process of stabilization of these materials is considered with respect to quenching, degradation, training, different $H_c(I_c)$ curves, flux jumps, anomalies in the function $I_c(H_c)$, and residual magnetic fields. The models of the transport mechanisms of currents in superconductors that permit qualitative interpretation of these phenomena are examined. The applications of superconductivity to superconductor cables, superconductor motors and generators, energy accumulators in superconductor magnetic devices, and superconductor magnets are examined. (J.S.R.)

42610 (NP-18355) FORTRAN-PROGRAM FOR THE COMPUTATION OF THE SURFACE IMPEDANCE OF SUPERCONDUCTORS. Halbritter, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Jun 1970. 20p. Dep. CFSTI (U. S. Sales Only).

The FORTRAN program presented in this report computes the surface impedance Z of superconductors in the Meissner state for frequencies lower than the energy gap. The formulas used are exact within the framework of the BCS theory for weak-

coupling superconductors. Strong-coupling effects can be introduced by using measured Δ/kT_c values. In the program the temperature dependence of the gap parameter $\Delta(T)$ is approximated by $(\Delta(T)/\Delta(0))^2 = \cos \pi/2\ (T/T_c)^2$. (auth)

42611 VALIDITY OF DIFFERENT CRITERIA FOR BOUND STATES AT MAGNETIC IMPURITY SITES IN SUPERCONDUCTORS. Fowler, Michael (Univ. of Virginia, Charlottesville). Progr. Theor. Phys. (Kyoto); 43: 571-7(Mar 1970).

A careful examination of the analytic structure of scattering amplitudes reveals that the criterion for bound states at magnetic impurity sites in superconductors used by Fowler and Maki is mathematically valid. An apparently equally plausible (and much more tractable) criterion is not. (auth)

42612 H_{c2} AND THE κ_2-PARAMETER OF A SUPERCONDUCTOR WITH CUBIC SYMMETRY. Takanaka, Kenji; Nagashima, Tomitaro (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 43: 18-26(Jan 1970).

The upper critical field H_{c2} and the κ_2 parameter of a pure superconductor with the cubic crystal symmetry are calculated near the transition temperature. The result obtained for H_{c2} is in good agreement with the experimental result of Farrell et al. It is found that the direction of the induced magnetic field is not parallel to that of the external magnetic field applied in an arbitrary direction. Therefore, the κ_2-parameter becomes a tensorial quantity. The ratio M_x/M_t is found to be about 0.015 at the reduced temperature t = 0.7, where M_x and M_t are respectively magnetizations perpendicular and parallel to the applied external field. (auth)

42613 SUPERCONDUCTIVITY IN A MOLECULAR FIELD. II. STABILITY OF FULDE–FERREL PHASE. Takada, Satoshi (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 43: 27-38(Jan 1970).

The stability of the Fulde–Ferrel phase is investigated in a simplified model. It is shown that the Fulde–Ferrel phase reduces by both potential scattering and spin–orbit scattering, and disappears at a critical value of the mean free time (τ_p or τ_{so}), which is about the reciprocal of the BCS energy gap Δ_0. As a result, the Fulde–Ferrel phase is excluded in a dirty superconductor such as the high-field superconductor. The possibility of the existence of the Fulde–Ferrel phase in the superconductor with impurity ferromagnetism is briefly discussed. (auth)

42614 INFLUENCE OF THE PHONON SPECTRA OF In–Tl ALLOYS ON THE SUPERCONDUCTING TRANSITION TEMPERATURES. Dynes, R. C. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B: 2: 644-56(1 Aug 1970).

A tunneling investigation of the effective phonon density of states through the four distinct crystal structures of the In–Tl alloy series has been performed. The resultant $\alpha^2(\omega)F(\omega)$'s extracted from these studies reflect the characteristics of each individual structure. The data obtained from these experiments serve as a test of existing theoretical expressions for determining T_c of a superconductor from normal-state parameters. It is found that the agreement is somewhat disappointing. In addition, a study of the phonon distribution, or more explicitly, an average phonon energy $\langle\omega\rangle$ in the region of the face-centered cubic to face-centered tetragonal phase transition, suggests an instability in at least one of the phonon modes. This result appears to support the suggestion that this transition is second-order. (auth)

42615 SUPERCONDUCTIVITY AND QUANTUM FLUIDS. Galasiewicz, Zygmunt M. International Series of Monographs in Natural Philosophy. Volume 29. Elmsford, N. Y.: Pergamon Publishing Company (1970). 244p. $10.50.

The microscopic theory of superconductivity and superfluidity is presented. Explicit derivations of the formulas are given. References give preference to the work due to Bogolyubov's school. Under superconductivity, the following are covered: The theory of the ground state, thermodynamics, collective oscillations, and electrodynamics. Under quantum fluids are the following: basic identities and relations, the ordinary Bose and Fermi fluids, the Bose superfluid, and the Fermi superfluid. (M.H.R.)

42616 INTRODUCTION TO SUPERCONDUCTIVITY. Rose-Innes, A. C.; Rhoderick, E. H. International Series of Monographs in Solid State Physics. Volume 6. Elmsford, N. Y.: Pergamon Publishing Company (1969). 244p. $9.50.

The physics of superconductivity is covered and, although applications are mentioned occasionally, they are not treated in detail. Under type-I superconductors the following subjects are presented: zero resistance, perfect diamagnetism, electrodynamics, the critical magnetic field, the thermodynamics of the transition, the intermediate state, transport currents in superconductors, the superconducting properties of small specimens, and the microscopic theory of superconductivity. Under type-II superconductivity the mixed state and critical currents are covered. (M.H.R.)

42617 ULTRASONIC ATTENUATION IN A SUPERCONDUCTING VANADIUM–TANTALUM ALLOY. Tittmann, B. R. (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Rev., B: 2: 625-37(1 Aug 1970).

Ultrasonic-attenuation measurements were carried out on the magnetically reversible, type-II superconductor V–5.6-at. % Ta with both a high Ginzburg–Landau parameter ($\kappa_G \approx 5$) and the Bardeen, Cooper, and Schrieffer (BCS) coherence length 5 times the electronic mean free path. The electronic attenuation α in zero magnetic field below T_c is BCS-like, giving a zero-temperature energy gap $2\Delta_0(0,0) \approx 3.6k_BT_c$, and in the normal state has the theoretically predicted dependence on q and l. The upper critical field H_{c2} could be deduced from the attenuation data to an accuracy better than 1%, and its temperature dependence agrees well with type-II theory without p-wave scattering of electrons. Use of the measured normal-state resistivity and ultrasonically determined values of T_c, $H_{c2}(T)$, and $\partial\alpha/\partial H$ at $H = H_{c2}$ inserted in an ultrasonic-attenuation theory due to Maki enabled the calculation of an Abrikosov–Maki parameter κ_2, which agreed roughly with the κ_2 obtained in previous magnetic and calorimetric measurements. Thus, for H close to H_{c2}, the data agree with Maki's dirty-limit ($\xi_0/l \gg 1$) theory, which predicts a linear dependence of α on H. At fields farther from H_{c2}, $\alpha(H)$ deviates from linearity and appears to fit empirically a parabolic function of H. At very low fields $H \gtrsim H_{c1}$, the H and T dependence of α is in apparent agreement with another theory. Physical insight into the behavior in this region could be obtained with a model in which vortices are replaced by cylinders of completely normal material imbedded in a superconducting matrix. (auth)

42618 MICROWAVE-PHOTON-ASSISTED TUNNELING IN Sn/I/Sn SUPERCONDUCTING TUNNEL JUNCTIONS. Sweet, J. N.; Rochlin, G. I. (Univ. of California, Berkeley). Phys. Rev., B: 2: 656-64(1 Aug 1970).

Comparatively low-frequency (3.93 GHz) microwave-photon-assisted quasi-particle tunneling in superconducting Sn–I–Sn tunnel junctions was studied. The junctions were situated in a perpendicular rf electric field of frequency ω, with microwave voltages V_{rf} satisfying the condition $eV_{rf}/h\omega \lesssim 18$. Excellent agreement with the rf power dependence predicted by the theory of Tien and Gordon has been obtained for junctions with normal resistances $\gtrsim 1\ \Omega$, although the calculated junction cavity fields remain an order of magnitude below field values needed to fit the data. As the junction resistance is decreased, agreement remains good at high rf power levels, but systematic discrepancies between theory and experiment occur at lower power levels. The interaction of microwave radiation with the zero-voltage Josephson current has been studied on the same junctions, and the response compared to the theoretical predictions of Werthamer. In this case quantitative agreement with the theory is generally poor and does not appear to be correlated with sample resistance. (auth)

42619 DETECTION OF A VORTEX-FREE REGION IN ROTATING LIQUID HELIUM II. Northby, J. A.; Donnelly, R. J. (Univ. of Oregon, Eugene). Phys. Rev. Lett.; 25: 214-17 (27 Jul 1970).

A nonlinear dependence of the number of vortex lines in a rotating container on the rotation frequency was observed. The data are consistent with a model in which there are about two missing rows of vortices near the walls. (auth)

42620 PHONON DISPERSION AND THE PROPAGATION OF SOUND IN LIQUID ^{4}He BELOW 0.6^{0}K. Maris, Humphrey J.; Massey, Walter E. (Brown Univ., Providence). Phys. Rev. Lett.; 25: 220-2(27 Jul 1970).

Recent experiments on the attenuation and velocity of sound in liquid ^{4}He at low temperatures are discussed in terms of the excitation model of liquid ^{4}He. By assuming for the long-wavelength excitations the dispersion relation $\epsilon(p) = cp[1-\gamma^2-\delta p^4\ldots]$ with γ negative, previous disagreements between theory and experiment are received. (auth)

42621 VELOCITY OF SOUND IN SUPERCONDUCTING LEAD FOR $ql > 1$. Deaton, B. C. (Applied Research Lab., Ft. Worth, Tex.). Phys. Lett.; 32A: 333-4(10 Aug 1970).

The change in velocity of sound at the superconducting transition temperature due to the dynamic interaction of the sound waves with the conduction electrons was measured for compressional waves in a lead single crystal. (auth)

42622 MIXING IN JOSEPHSON TUNNEL JUNCTIONS. Chen, J. T. (Univ. of Pennsylvania, Philadelphia). Phys. Lett.; 32A: 347-8(10 Aug 1970).

Current structures at voltages corresponding to the mixing of rf-field and junction resonant modes were observed in strong-coupling Josephson junctions. (auth)

42623 VARIOUS EQUATIONS OF MOTION FOR THE ORDER PARAMETER IN HELIUM II. Haug, H.; Weiss, K. (Philips Research Labs., Eindhoven, Netherlands). Phys. Lett.; 32A: 349-50(10 Aug 1970).

Recently, Khalatnikov modified an equation of motion for the order parameter in helium II near Tλ that was originally derived by Pitaevskii from thermodynamical arguments. It is shown that both equations are in contradiction with the microscopically derived order-parameter equation by Froelich. The modifications necessary to achieve agreement with Froelich's equation are given. (auth)

42624 EFFECTS OF THERMAL INSULATION ON FLUX JUMPS IN Nb-50 PER CENT Ti RODS. Chikaba, J. (Kyushu Univ., Japan). Cryogenics; 10: 306-13(Aug 1970).

The temperatures of Nb-50% Ti rods were observed as functions of an external magnetic field, when the rods were thermally insulated from liquid helium. As the field was increased, the temperature began to fluctuate and built up to a flux jump, in which the sweep rate seriously affected the starting point of a flux jump. These results are analysed theoretically and the observed behaviour of the temperature variation is explained semi-quantitatively. The conditions for the occurrence of flux jumps are also discussed. (auth) (UK)

42625 SPATIAL VARIATIONS OF THE ORDER PARAMETER IN SUPERCONDUCTORS CONTAINING A MAGNETIC IMPURITY. Kitamura, Toyoyuki (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 43: 271-85(Feb 1970).

By taking into account the Kondo effect, the spatial variation of the order parameter in superconductors containing a single magnetic impurity is discussed. The method of the double-time Green function used by Zuckermann, and Takano and Matayoshi is used, and the methods of Zittartz and Mueller-Hartmann and Kondo are followed to solve the equation for the t-matrix. The spatial variation of the order parameter is obtained by a method similar to that of Heinrichs. Only the case in which the temperature is very close to T_c and $|\ln T_K/T| = |\tau|$ (T_K: Kondo temperature) is very large is considered. The spatial variation of the order parameter is considered up to the terms of the order of $(1/\tau)^3$. The main effect is to replace γ^2 by $1/\tau^2$ is expression of the spatial variation of the order parameter and of the transition point. The term $1/\tau^3$ yields the asymmetry for $\tau > 0$ and $\tau < 0$, i.e., $T \ll T_K$ and $T \gg T_K$. (auth)

42626 NONLINEAR RESPONSE ABOVE THE SUPERCONDUCTING TRANSITION POINT. III. GINZBURG-LANDAU-GORKOV APPROXIMATION. Tsuzuki, Toshio (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 43: 286-302(Feb 1970).

The nonlinear excess conductivity due to the pair fluctuation is recalculated in the Ginzburg-Landau-Gorkov approximation. The nonlinear effect is very sensitive to the purity of sample, and the reduction from the Aslamazov-Larkin formula is not small. The width of the transition becomes narrower in a pure sample due to the nonlinear effect. Discussions of the experiments and of the future problems are given. The possibility of applying the Langevin method to the Ginzburg-Landau equation is microscopically established in order to explain the critical phenomena in the classical range of temperature. (auth)

42627 ANISOTROPY OF Nb_3Sn SUPERCONDUCTING TAPE AND ITS EFFECT ON THE PERFORMANCE OF SUPERCONDUCTING MAGNETS. Jergel, M.; Hlasnik, I. (Electrotechnical Inst., Bratislava). Cryogenics; 10: 323-5(Aug 1970).

The critical current density of Nb_3Sn diffusion-processed superconducting tape in a transverse magnetic field was studied experimentally as a function of tape orientation and processing temperature (800 to 1150°C). For a given magnetic field, those samples heat treated between 920 and 940°C were found to have the maximum critical current and the maximum ratio of anisotropy (for example, $I_{c\parallel}/I_{c\perp} = 1.90$ at 10 kG, 1.45 at 50 kG). The efficiency of the solenoid winding configuration was analysed in terms of the anisotropy of the tape and of the intensity of the magnetic field. For a tape with the above values of $I_{c\parallel}/I_{c\perp}$, the construction of a solenoid with more than one section is found to be advantageous only when the maximum field is more than 25 kG. (auth) (UK)

42628 ELECTRICAL CONDUCTIVITY AND SUPERCONDUCTIVITY IN In_5Bi_3. Cruceanu, E.; Hering, E.; Schwarz, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Phys. Lett.; 32A: 295-6(10 Aug 1970).

Measurements of the electrical resistivity and Hall effect were carried out on In_5Bi_3 single crystals. The data enable the determination of the Ginzburg-Landau parameter κ, as well as some transport properties of In_5Bi_3. (auth)

42629 FLUX PINNING BY PHASE BOUNDARIES IN TYPE-II SUPERCONDUCTORS. Evetts, J. E. (Cambridge Univ., Eng.). Phys. Rev., B; 2: 95-6(1 Jul 1970).

Measurements have been made, from magnetization curves, of the surface hysteresis in PbTl in low fields. The surface was plated with Tl and diffused for various periods so that the distance in which the specimen changed from normal to superconducting varied from a few atomic diameters to several times the penetration depth. It was found that plating had little effect, but that the hysteresis dropped markedly on diffusing over a distance λ. The results indicate that magnetic pinning to the surface is the predominant factor, rather than surface "sheath" currents. (auth)

42630 DISTRIBUTION OF THE ENERGY GAP IN k SPACE FOR SUPERCONDUCTING Nb. MacVicar, M. L. A. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., B; 2: 97-100 (1 Jul 1970).

Examination of available tunneling data from junctions oriented on single-crystal niobium shows that the observed superconducting energy gap values are grouped nonrandomly in k space. These groupings are consistent with a relationship between $\Delta_{(k)}$ and Fermi-surface topology, but also suggest a significant role for phonon anisotropy. (auth)

42631 ULTRASONIC-ATTENUATION STUDIES IN SUPERCONDUCTING LEAD. Randorff, J. E.; Marshall, B. J. (Texas Tech. Univ., Lubbock). Phys. Rev., B; 2: 100-4(1 Jul 1970).

Measurement of the attenuation of 10-, 30-, 50-, and 70-MHz longitudinal sound waves, propagated in the [100], [110], and [111] directions, was conducted on the normal and superconducting states of lead. Analysis of the data was presented allowing for the possibility of multiple energy gaps. The data were also compared to theoretical calculations for a strong coupling model. (auth)

42632 ANOMALOUS H_{c3}/H_{c2} NEAR T_c IN Pb-In AND CRITICAL PHENOMENA IN THE SUPERCONDUCTING SHEATH. Rollins, R. W.; Cappelletti, R. L.; Fearday, J. H. (Ohio Univ., Athens). Phys. Rev., B; 2: 105-8(1 Jul 1970).

The measured ratio of the critical field for the sheath state to that for the vortex state H_{c3}/H_{c2} increases sharply above the Saint James-de Gennes value of 1.695 near T_c in Pb-8.7 at. % In alloy samples with several surface preparations. The sudden increase beginning at temperatures above $0.96T_c$ for the relatively short mean free path Pb-In alloy is in sharp contrast to the precipitous drop of H_{c3}/H_{c2} beginning at about 0.85 T_c that has been observed by others in pure Nb and V. The Nb experiment was interpreted in terms of a critical phenomenon. The observations of anomalous behavior over a narrower reduced temperature interval in the dirty Pb-In alloy than that in clean Nb and V is used (i) to argue that an interpretation of both effects based solely on a critical phenomenon is not valid and (ii) to suggest that neither effect is solely a critical phenomenon. A model recently advanced by Hu, which does not appeal to critical phenomena at all, may be used to describe both sets of results. In terms of Hu's parameters, the results in Pb-In correspond to $\delta V/V_0 \simeq 10^{-4}$ and $D \geq 17\xi(0)$. A simple description of the Pb-In results consistent with Hu's model is that the "critical temperature" of the surface is enhanced by 0.1% relative to that of the bulk. (auth)

42633 JOSEPHSON EFFECT IN A SUPERCONDUCTING RING. Bloch, F. (Stanford Univ., Calif.). Phys. Rev., B; 2: 109-21(1 Jul 1970).

The Josephson effect in a superconducting ring, interrupted by a barrier, is shown to be the direct consequence of fundamental principles and, hence, to exactly obey the voltage-frequency relation used for a precise determination of e/h. Supplementary considerations deal with the role of electron pairing and with additional features such as those found in the presence of two parallel junctions. The special case of a thin ring is used to illustrate the treatment of dynamical properties, including the possible occurrence of hysteresis. A more-detailed discussion of the effects due to a potential barrier is presented, followed by a rederivation of Josephson's differential equation, which is seen to govern the time dependence of the penetrating flux. (auth)

42634 ULTRASONIC LONGITUDINAL-WAVE ATTENUATION IN SUPERCONDUCTING MERCURY. Wu, H. C.; Bohm, H. V.; Thomas, R. L. (Wayne State Univ., Detroit). Phys. Rev., B; 2: 122-8(1 Jul 1970).

Results of measurements of the attenuation of longitudinal-wave ultrasound in pure single crystals of mercury in both the normal and superconducting states are presented. Measurements were made for frequencies from 10 to 320 MHz and for three different crystallographic directions of sound propagation. A distinct frequency-dependent behavior was observed, and is consistent with a state-dependent electron mean free path. Tests for dislocation damping mechanisms in the background attenuation were negative: No amplitude dependence was observed over a 60-dB dynamic range, and reasonable fits to the frequency and field dependence of the data at various temperatures were made, using free-electron theory. An anomalous behavior persists

in the high-frequency limit that cannot be explained in terms of a single-energy-gap BCS theory. (auth)

42635 GAP EQUATIONS FOR THE TWO-BAND SUPERCONDUCTORS IN THE PRESENCE OF NONMAGNETIC IMPURITIES IN THE CASE g_s, g_d, $g_{sd} \neq 0$. Tang, I-ming. (Reed Coll., Portland, Oreg.). Phys. Rev., B; 2: 129-35(1 Jul 1970).

The effects of nonmagnetic impurities on the two-band model as proposed by Suhl, Matthias, and Walker for superconducting states of the transition metals are formally extended to the general case g_s, g_d, $g_{sd} \neq 0$. Use is made of Dyson's equation to obtain the 4×4 matrix; the order-parameter (gap-energy) equations are formally obtained for the general case. In going to the interband phonon-coupling limit $g_s = g_d = 0$, or to the intraband limit $g_{sd} = 0$, the results obtained reduce to those found by Chow. The effect of the impurity scattering on the critical temperature for the two-band superconductor in the general case is discussed. (auth)

42636 PARAMETER $\kappa_2(T)$ FOR STRONG-COUPLING SUPERCONDUCTING ALLOYS. Usadel, Klaus D. (Univ. of Montreal). Phys. Rev., B; 2: 135-40(1 Jul 1970).

The parameter $\kappa_2(T)$ is studied for superconducting alloys (dirty limit) in the electron–phonon model. An equation for $\kappa_2(T)$ is derived which contains the frequency-dependent part of the order parameter right at the transition from the normal to the superconducting state and which can be used as a starting point for a detailed numerical calculation. At T_c, κ_2 is expressed in terms of other measurable quantities, and at $T = 0$ a rough estimate of the order of magnitude of the strong coupling corrections to κ_{2BCS} is given. It is found that the strong coupling corrections to κ_2 are very small, even for lead. (auth)

42637 SUPERCONDUCTIVE PROPERTIES OF THE EXCITONIC INSULATOR. Parmenter, R. H.; Henson, W. R. (Univ. of Arizona, Tucson). Phys. Rev., B; 2: 140-7(1 Jul 1970).

Analysis of a simple model of the excitonic insulator shows that the ordered phase exhibits electrical superconductivity whenever the conduction-band mass differs from the valence-band mass. Interband scattering of electrons by the magnetic vector potential plays an essential role. States of finite electric persistent current are demonstrated explicitly. The excitonic insulator is a system where diagonal versus off-diagonal long-range order is a function of one's bookkeeping. (auth)

42638 MAXIMUM dc JOSEPHSON CURRENT IN $Pb/PbO_x/Pb$ JUNCTIONS. Schwidtal, K.; Finnegan, R. D. (Army Electronics Command, Fort Monmouth, N. J.). Phys. Rev., B; 2: 148-54(1 Jul 1970).

The magnetic field dependence of the maximum dc Josephson current for square $Pb/PbO_x/Pb$ Josephson junctions was measured, with the ratio of junction width w to Josephson penetration depth λ_J as a parameter that was systematically varied. For wide Josephson junctions, the maximum dc Josephson current in zero external magnetic field I_0 is limited by the current-induced self-field, while for very narrow Josephson junctions, I_0 is limited by thermal noise. However, it is shown that for square Pb/Pb Josephson junctions with $1.00 > w/\lambda_J > 0.22$, the self-field as well as thermal noise is negligible. For these junctions, the experimental results are in consistent agreement with the theoretical prediction of Fulton and McCumber, who have shown that strong-coupling effects will reduce I_0 to 78.8% of the weak-coupling prediction for Pb/Pb junctions. Evidence is presented for the uniformity of the PbO_x tunneling barrier layers, and a model for the formation of the PbO_x layers. (auth)

42639 NUMERICAL EVALUATION OF THE FREQUENCY-DEPENDENT COMPLEX CONDUCTIVITY OF SUPERCONDUCTING MERCURY. Harris, Richard E. (United Aircraft Research Labs., East Hartford, Conn.). Phys. Rev., B; 2: 228-30(1 Jul 1970).

The ratio of the frequency-dependent complex conductivity of superconducting mercury to that of normal mercury is calculated numerically from recent tunneling data of Hubin and Ginsberg. (auth)

Plasma and Thermonuclear Physics

42640 (NP–18360) WILLS PLASMA PHYSICS DEPARTMENT NINETEETH SIX-MONTHLY PROGRESS REPORT, 1st JANUARY–30th JUNE 1970. (Sydney Univ. (Australia). School of Physics). 10p. (PR–19). Dep. CFSTI (U. S. Sales Only).

Research in the department is briefly reviewed, under the following headings: (1) plasma sources, (2) hydromagnetic ionizing fronts, (3) hydromagnetic waves in nonuniform magnetic fields, (4) laser diagnostics, (5) microwave techniques of afterglow in SUPPER I, (6) electron cyclotron harmonic resonances in SUPPER V, (7) far infrared. Recent research reports are also listed. (Australia)

42641 PLASMA PHYSICS INDEX. VOLUME 5, NO. 6, 1970. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 134p.

This listing includes 641 articles on various aspects of plasma physics. (M.O.W.)

Confinement and Heating

Refer also to abstract 42702.

42642 (D–1–82–977) ELECTROMAGNETIC CONFINEMENT AND PENETRATION OF AN OVERDENSE PLASMA. Hall, R. B.; Gerwin, R. A. (Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.). May 1970. 17p.

For a simple model, it is possible to compute the self-consistent confinement and penetration of an energetic electron plasma by an rf field of large amplitude, when the quantity $[(v/c)/(\omega_P/\omega)]$ is of order unity or greater, where v is a characteristic electron speed, ω_p is the plasma frequency, and ω is the rf frequency. Previous theories concerning nonlinear behavior of electromagnetic waves in plasmas have required this quantity to be very small compared to unity. (auth)

42643 (EUR-CEA-FC–538) KINETICS OF OHMIC HEATING IN A TOROIDAL CONFIGURATION. Girard, J. P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1970. 48p. (In French). Dep. CFSTI (U. S. Sales Only).

The properties of a plasma produced by ohmic heating, and confined in a toroidal configuration are described. A simplified model of the plasma is used in which the most important inelastic collisions, the gas cycle, and the diffusion of matter and energy are considered. The importance of the physical properties of the walls containing the plasma are demonstrated. The calculations are applied to the existing machines (C Stellarator and Tokamaks) and allow the technological quality of the experiments to be realized and the distribution of particles and energy to be determined. (France)

42644 (NP–18340) TRANSPORT PROCESSES IN TOROIDAL MAGNETIC TRAPS. I. INITIAL EQUATIONS. Preprint No. 38. Kovrizhnykh, L. M. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1970. 44p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The first part of a detailed theoretical analysis of the problem of collisional diffusion in closed magnetic traps is presented. It includes the systematic derivation of basic equations for construction of the theory of transport processes in toroidal systems having complex magnetic-field geometry, specifically, the derivation of drift kinetic equations, expressions for particle and energy fluxes, collision integrals, and finally, general relations necessary for future analysis of transport processes. (tr-auth)

42645 RESONANT PARTICLES IN ELECTRON CYCLOTRON HEATING OF PLASMA. Ivanov, A. A.; Spektor, M. D.; Frank-Kamenetskii, D. A. JETP Lett. (USSR) (Engl. Transl.); 11: 84-5 (20 Jan 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 136-8 (20 Jan 1970).

Earlier investigations of electron cyclotron plasma heating have revealed the presence of a group of high-energy electrons (several times 10 keV), exceeding by many orders of magnitude the average energy of the plasma electrons. The origin of the hot electrons is stated to be resonant particles, whose Doppler-shifted frequency coincides with the cyclotron frequency $\omega - \omega_c = k_z V_z$. It is shown that this assumption leads directly to a correct estimate of the energy of the hot electrons. (M.O.W.)

42646 ION ENERGY BALANCE IN THE PLASMA OF A TOKAMAK MACHINE. Artsimovich, L. A.; Gluckhov, A. V.; Petrov, M. P. JETP Lett. (USSR) (Engl. Transl.); 11: 304-7(5 May 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 449-52(5 May 1970).

Measurements of the neon temperature in Tokamak devices, by analyzing the energy spectrum of the charge-exchange atoms, show that T_i increases with increasing plasma concentration and decreases with increasing ion mass. An analysis was made for the heating of ions due to Coulomb collisions with electrons. (M.O.W.)

42647 EXPERIMENTAL INVESTIGATION OF THE TRANSVERSE INJECTION OF A DENSE PLASMA INTO A LINEAR

OCTUPOLE. Boyd, J. A.; Duesterhoeft, W. C. Jr. (Univ. of Texas, Austin). Plasma Phys.; 12: 149-64(Mar 1970).

The transverse injection is investigated under conditions such that the static octupole field near the entrance is virtually cancelled by the diamagnetic currents in the plasma and also under conditions such that the field is essentially undisturbed. The average time-resolved motion of the plasma under both conditions as a function of average velocity of the injected plasma is determined. Calculations are also made from magnetic and electric probe data which account for the transfer of the momentum of the streaming plasma to the supporting structure. (auth) (UK)

42648 NON-DIFFUSIVE EFFECTS IN THE RADIATIVE PROPAGATION OF A THERMAL PULSE. Traugott, S. C. (Research Inst. for Advanced Studies, Baltimore). Phys. Fluids; 13: 2242-52(Sep 1970).

The very early, pre-hydrodynamic transport of energy by radiation in a strong explosion is studied, taking departures from the Rosseland diffusion approximation into account. Similarity solutions exist for the plane, cylindrical, and spherical cases when the grey absorption coefficient varies as a power of temperature which is 1, $\frac{1}{2}$, and $\frac{1}{3}$, respectively. Solutions are found for the plane and spherical cases using both the technique of matched asymptotic expansions and numerical integration. These solutions allow computation of temperatures and heat flux as a function of time, distance from the center, and energy release. Nondiffusive radiation leads to a relatively cool precursor to the main portion of the thermal wave. This precursor is much less pronounced in the spherical case. It is also found possible to predict the temperature visible to a distant observer. (auth)

42649 TURBULENT HEATING EXPERIMENT. Hsieh, C. L.; Lichtenberg, A. J. (Univ. of California, Berkeley). Phys. Fluids; 13: 2317-31(Sep 1970).

Results are presented of an experimental investigation of turbulent heating. A current parallel to the mirror magnetic axis, produced by discharging a capacitor, excites an interaction and, with proper conditions (plasma density, magnetic field strength for trapping), it is found that some class of turbulently heated plasma electrons can be adiabatically compressed to high temperature. In the most favorable heating conditions electrons are heated to 85 keV at 25 kG (factor of 40 in magnetic compression). This corresponds to $T_e \simeq 2$ keV immediately after turbulent heating, which is approximately equal to the total drop across the electrodes. The interaction is characterized by an anomalously high resistance, and radiation that covers a broad range up to the electron plasma frequency and including the frequency range corresponding to the electron–ion streaming instabilities. At low density ($< 10^{12}$ cm^{-3}), a sheath is generated giving rise primarily to the beam plasma interaction. In the intermediate density range $2 \times 10^{12} - 10^{13}$ cm^{-3} the anomalous resistivity had approximately a $n^{-\frac{1}{2}}$ dependence, characteristic of the current-convective mode. At densities over 2×10^{13}, all interactions are quenched due to the voltage drop across the self-inductance of the discharge circuit including the plasma column. The results are compared with related turbulent heating experiments. (auth)

42650 PLASMA HEATING BY REFLECTED IONIZING SHOCK WAVES. Taussig, Robert T. (Columbia Univ., New York). Phys. Fluids; 13: 2270-4(Sep 1970).

Ionizing shocks reflected by a transverse magnetic field "barrier" heat and compress the plasma at the barrier. Numerical results are presented for an ideal gas (typical values for hydrogen initially at 100 Mtorr and room temperature). Resolution of the arbitrary discontinuity formed by the incident shock at the barrier field is discussed in detail. The recent work of Bout and Gross is extended to an additional branch of solutions corresponding to applied magnetic fields greater than their critical field. Calculations using a simplified transverse ionizing shock structure are compared to the pure gas-dynamic and pure magnetohydrodynamic cases. The range of validity of the ideal gas approximation is reviewed briefly. (auth)

42651 PLASMA LOSS STRUCTURE IN A LINEAR MULTIPOLE. Palladino, R. W. (Princeton Univ., N. J.). Phys. Fluids; 13: 2413-17(Sep 1970).

The dominant losses from hot electron plasmas in the Princeton linear quadrupole device have been found to be radially outward. When this nonclassical radial loss was studied in detail, a surprising amount of variation was found in the amplitude of the loss rate as seen moving parallel to the current-carrying conductors, which led to the further discovery of spatial variations of internal plasma parameters, particularly plasma density. Efforts to correlate the anomalously large loss zones with local perturbations, obstructions, fluctuations, or variations in plasma heating and ionization were only partially successful. The periodic structure in plasma density and charged-particle loss rates apparently reflects stable, internally supported modes that have lifetimes longer than the plasma lifetime presently being considered; i.e., $> 10\tau_{Bohm}$. (auth)

42652 CONTROLLED FUSION: PLASMA CONFINEMENT WITH LASERS. Thorne, James M. (Brigham Young Univ., Provo, Utah). Science; 169: 893-4(28 Aug 1970).

The use of circularly polarized laser radiation for sufficient magnetic fields for plasma confinement is briefly discussed. Magnetic field strengths possible are estimated. (M.O.W.)

42653 INTERFACE OF A UNIFORM PLASMA ENVELOPED BY THE MAGNETIC FIELD OF A SYSTEM OF LINE CURRENTS. Sozou, C. (Univ. of Sheffield, Eng.). J. Plasma Phys.; 3: 651-60(Dec 1969).

It is shown that complex variable transformations, suitable for obtaining the solution for the field boundary of a system of line currents confined in one cavity by a perfectly conducting uniform plasma, can be used for obtaining the solution to the inverse problem where a perfectly conducting uniform plasma is confined in one cavity by a system of line currents. It is deduced that the minimum number of line currents for confining (not stably) a plasma is two. The equilibrium configurations for several special, but simple, cases are investigated and discussed. (auth)

42654 WEAK TURBULENCE AND ANOMALOUS DIFFUSION. Timofeev, A. V. JETP Lett. (USSR) (Engl. Transl.); 11: 377-9 (5 Jun 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 547-9 (5 Jun 1970).

A brief theoretical analysis is given for plasma diffusion in magnetic fields. The effects of low-frequency drift-type oscillations on the diffusion coefficients and the effects of random electric fields are analyzed. (M.O.W.)

42655 TEMPORAL AND SPATIAL ORIGIN OF HOT IONS IN TURBULENT HEATING OF A PLASMA. Kawabe, T.; Iannucci, J.; Eubank, H. (Princeton Univ., N. J.). Phys. Rev. Lett.; 25: 642-6(7 Sep 1970).

Plasma heating by turbulent current flow was studied by means of particle analysis. The spatial and temporal origin of hot ions was determined and compared with the temporal change of the resistivity and the amplitudes of the high- and low-frequency fluctuations in the plasma. (auth)

Diagnostics

42656 (INR–1173) SPECTROSCOPIC MEASUREMENTS OF THE RADIAL TEMPERATURE DISTRIBUTION IN POWDER SEEDED ARGON PLASMA. Lesinski, Jacek (Institute of Nuclear Research, Warsaw (Poland)). 1970. 37p. (In Polish). Dep. CFSTI (U. S. Sales Only).

Studies on temperature distribution in powder seeded-induction plasma torches are described. The gas was argon and the powder material was $Al_2O_3 \cdot TiO_2$. Nominal output power of the supplying rf generator amounted to 10 kW and its frequency 2.9 MHz. Radial and axial temperature distribution was measured in clean argon plasma for four values of supply power. Radial temperature distribution in powder-seeded argon plasma was measured with the intensity line ratio method and absolute Ar line and continuum intensity methods. Temperatures obtained from intensities of powder material atoms are much less and their radial distribution is different from that obtained from argon spectra. (auth)

42657 (ORNL–TM–3092) FRACTIONAL FRINGE HCN LASER-INTERFEROMETER. Olsen, J. N. (Oak Ridge National Lab., Tenn.). Aug 1970. 14p. Dep. CFSTI.

An HCN laser-interferometer is reported with better than 1/100th of a fringe phase-shift sensitivity at a wavelength of 337 μ. Applied to plasma density measurement this corresponds to electron density line integrals of 3.3×10^{12} cm^{-2} or lower. The fractional fringe technique involves sinusoidally driving the reference path mirror in a focused Michelson interferometer; changes in the effective path length alter the relative magnitude of even and odd harmonics in the resultant interferometer signal. Results are shown from application of this diagnostic to the Burnout V plasma. (auth)

42658 (SIT–2582–34) EXPERIMENTAL INVESTIGATION OF CUSPED CONTAINMENT GEOMETRIES CHALICE. Annual Report, September 1, 1969–August 31, 1970. Yevick, George J.; Harvey, Robin (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). Contract AT(30-1)-2582. 108p. (SIT–255). Dep. CFSTI.

Data taken by Thomson scattering in the cusp region of Chalice shows a non-Maxwellian distribution. A preliminary explanation is that the plasma consists of two components, 90% of the electrons having a temperature of ≈100 eV and a 10% directional cold component with a kinetic energy ≈10 eV. This cold component is believed to lie in the sheath and is induced by the external current. At 15 kV in the main bank, the deuterium bremsstrahlung due to the increased density in the cusp overwhelms the Thomson scattering signal for a time >8 μsec. Because soft x rays last for at least 15 μsec, the conjecture is that hot plasma prevails for times greater than 8 μsec. A more powerful laser beam is required to verify this. The efficacy of the "vanishing mirrors" was demonstrated by comparing the containment times of two otherwise similar coil systems. A factor-of-six increase is obtained with the mirrors (3 to 18 μsec). Improved diagnostics in the form of a new multimode interferometer yielding a sensitivity 40 times greater than the Mach–Zehnder were developed. The theory for measuring the full phase-space distribution function f(x,v) by using two different wavelengths of incident light on the plasma was elucidated. (auth)

42659 MEASUREMENTS ON STATIONARY COLLISIONLESS HYDROMAGNETIC SHOCK WAVES. Martone, M.; Serge, S. E. (CNEN, Frascati, Italy). Plasma Phys.; 12: 205-6(Mar 1970).

A fast-rising magnetic field is applied during the afterglow of an axial discharge, and the cylindrical shocks produced are investigated, using magnetic probes and laser light scattering. (UK)

42660 INTERFEROMETRY OF RAPID PHASE OBJECTS BY HOLOGRAPHY WITH TWO WAVELENGTHS. Hirth, Antoine (Institut Franco-Allemand de Recherches, Saint-Louis, France). Compt. Rend., Ser. B; 271: 28-30(6 Jul 1970). (In French).

A means of producing interference holograms of simultaneous rapid-phase objects with two wavelengths is described. The 6943-Å ruby line and its 3471-Å harmonic are used. Interferograms of dense plasmas are suggested as examples of the applications of the technique. (tr-auth) (France)

42661 ION CURRENT TO A SPHERICAL PROBE IN A FLOWING HIGH-PRESSURE PLASMA UNDER THIN-SHEATH CONDITIONS. Clements, R. M. (Univ. of Victoria, British Columbia); Smy, P. R. Proc. Inst. Elec. Eng. (London); 117: 1721-4(Aug 1970).

The current to a large (radius = 2.4 mm) negatively biased spherical probe in a flowing plasma (a propane/air flame) was measured over wide ranges of plasma-ionization density (3×10^{15} to 10^{18} m^{-3}), probe bias (10 to 400 V) and probe/plasma relative velocity (3 to 40 m/s). Under these conditions, the sheath surrounding the probe is thin and the probe current is a function of the probe/plasma velocity. In consequence, the static continuum probe theory of Su and Lam (1963) and the motionally dependent thick-sheath theory of Clements and Smy (1969) are both found to be in error by at least an order of magnitude. A thin-sheath relationship was derived for the spherical probe which shows excellent agreement with the experimental data: $I = 12 \cdot 13(\mu\epsilon_0)^{\frac{1}{2}}(n_e e v_f)^{\frac{1}{2}} V^{\frac{1}{2}} r_p^{\frac{1}{2}}$ where I = probe current, μ = ionic mobility, ϵ_0 = permittivity of free space, n_e = ionization density, e = electron charge, v_f = flow velocity, V = probe bias and r_p = probe radius (all in MKS units). (auth) (UK)

42662 DENSITY PROFILE MEASUREMENT USING AN ELECTROMAGNETIC WAVE IN THE EXTRAORDINARY MODE. Tulle, P. A. (CEN, Fontenay-aux-Roses, France). Phys. Fluids; 13: 2335-40(Sep 1970).

A method is presented for the measurement of spatial distributions of electron plasma density. It is based upon the reflection of the extraordinary mode ($\vec{k} \perp \vec{B}_0$, $\vec{E} \perp \vec{B}_0$) due to cutoff which occurs for a frequency ω, satisfying $(\omega_p/\omega)^2 = 1 - \omega_c/\omega$, instead of $(\omega_p/\omega)^2 = 1$ for the ordinary mode ($\vec{k} \perp \vec{B}_0$, $\vec{E} \parallel \vec{B}_0$). Consequently, the principle advantages are extension of the domain of plasma density measurements for a particular microwave frequency, and determination of the complete density profile by varying the frequency within the band of a single generator. Accurate results can be obtained because relative measurements of the density profile are made. Their interpretation is accomplished with a computational aid which calculates the propagation of the wave through the nonuniform plasma. (auth)

42663 MEASUREMENT OF SPECTRUM OF TURBULENCE WITHIN A COLLISIONLESS SHOCK BY COLLECTIVE SCATTERING OF LIGHT. Daughney, C. C.; Holmes, L. S.; Paul, J. W. M. (Culham Lab., Abingdon, Eng.). Phys. Rev. Lett.; 25: 497-9(24 Aug 1970).

Experimental evidence is presented for the presence of current-driven ion-wave turbulence within a collisionless shock. The frequency and wave-number spectra of this turbulence were measured by scattering light from the shock front. These measurements are compared with the assumptions and predictions of nonlinear theory. (auth)

42664 MEASUREMENTS OF HIGH ELECTRON DENSITIES BY THE TM_{010} CAVITY. Takeda, Susumu; Yasuda, Akio (Nagoya Univ., Japan). Jap. J. Appl. Phys.; 9: 806-11(Jul 1970).

The microwave-cavity method is developed to measure the electron density much higher than the cutoff. The approximate equation is deduced to determine the electron density and collision frequency from the frequency shift and the change of the Q value of the TM_{010} cavity. The frequency shift is the small difference between the resonant frequency for extremely high electron density and that for infinite one. The measurements are performed for the high-density region of the afterglow in a helium plasma at the pressures of 3.0 and 10.0 torr. The ranges of the measured electron densities and collision frequencies are, respectively, from 10^{13} to 10^{15} cm^{-3} and from 2.5×10^9 to 2.5×10^{10} sec^{-1}. The used microwave frequency is 4 GHz. To confirm the values measured by the cavity method, laser interferometry and the spectroscopic method are also performed. The values measured by these three methods are not in perfect agreement, but show that the cavity method is sufficiently reliable. (auth)

Kinetics (General)

42665 INTERACTIONS OF A PLASMA WITH A SPIRALING ELECTRON BEAM. Kusse, B. R.; Bers, Abraham (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids; 13: 2372-84 (Sep 1970).

A hollow, spiraling electron beam with energies along and across the applied magnetic field (B_0) was injected into argon (7×10^{-5} torr) to produce a plasma. With increasing plasma density, oscillations were observed at frequencies above integral multiples of the electron cyclotron frequency. A theoretical study of the coupling between electrostatic plasma waves and waves on a spiraling beam is shown to predict the observed frequencies and wavelengths. The theoretical analysis accounts for the finite thickness of the beam and for finite Larmor-radius effects in the plasma. The latter are shown to explain the sudden jumps in the observed frequencies that resulted when the plasma density increased. The results show that a spiraling beam with energy across B_0 is able to transfer some of this energy to the plasma even when the electrons are hot. (auth)

42666 POSITIVE COLUMN OF DISCHARGES IN HELIUM AT INTERMEDIATE PRESSURES. I. IONIZATION MECHANISM AND ATOMIC LEVEL POPULATIONS. Mewe, R. (EURATOM–FOM, Rijnhuizen, Netherlands). Physica; 47: 373-97(5 Jun 1970).

The ionization rate in a helium plasma is computed for conditions applicable to the case of the positive column in a dc discharge. The parameters are: filling gas pressure p = 0.1 to 10 torr, electron density $n_e = 10^{14}$ to 10^{16} m^{-3}, reduced axial electric field strength E/p = 100 to 6000 V m^{-1} $torr^{-1}$, and plasma radius R = 0.005 to 0.02 m. Stepwise processes via the four lower excited levels of the helium atom are taken into account. The electron energy distribution is non-Maxwellian. In order to check the computed level populations, a dual-beam absorption experiment is carried out on a cylindrical discharge. The parameters are: p = 0.1 to 2 torr, E/p = 300 to 4000 V m^{-1} $torr^{-1}$, current I = 0.01 to 0.4 A, and inner tube radius R = 0.011 m. In the region where no striations occur in the positive column, the measured and the calculated level populations agree within a factor of two. (auth)

42667 POSITIVE COLUMN OF DISCHARGES IN HELIUM AT INTERMEDIATE PRESSURES. II. PLASMA PARTICLE BALANCE AND DISCHARGE CHARACTERISTICS. Mewe, R. (FOM-Instituut voor Plasma-Fysica, Rijnhuizen, Netherlands). Physica; 47: 398-411(5 Jun 1970).

Corrections on the plasma particle balance owing to deviations from the ambipolar Schottky theory are studied. The effects of ion inertia (transition to free fall theory), deviations from quasi-neutrality (transition to free diffusion theory), and stepwise ionization (Spenke theory) are introduced in the form of a numerical correction factor. Also other effects are briefly considered, i.e., gas heating, dependence of ion mobility on temperature and electric field, conversion of He^+ into He_2^+, electron–ion recombination, and the presence of an axial magnetic field. From the plasma balance various characteristics in a diagram of E/p against pR are derived with the aid of values of the ionization rate that result from computations in which stepwise processes are taken into account. Here E is the strength of the axial electric field along a cylindrical discharge, p is the filling gas pressure, and R is the inner tube radius. The theoretical results show a good agreement with measurements of E in the positive column of a dc discharge in helium for the parameters: p = 0.1 to 2 torr, E/p = 300 to 4000 V m^{-1} $torr^{-1}$, current I = 0.01 to 0.4 A, and R = 0.011 m. (auth)

Kinetics (Experimental)

Refer also to abstract 42716.

42668 STUDIES OF THE EFFECTS DUE TO THE DIFFERENT POLARITIES OF AN INTERMEDIATE ELECTRODE ON THE SPECTRUM OF A CESIUM PLASMA. Fabry, Michel; Cussenot, Jean-Rene; Vicherat, Andre (Univ., Nancy). Compt. Rend., Ser. B; 270: 1469-72(8 Jun 1970). (In French).

The spectrum of a cesium plasma produced by a hot-cathode discharge was studied. Different potential configurations in the discharge space were achieved by altering the polarity of an intermediate grid; the emission spectra of neutral cesium and the Cs^+ ion were observed. (tr-auth) (France)

42669 REPELLING OF ELECTRON BEAM WITH LOCAL ELECTRON CYCLOTRON RESONANCE. Sugawa, M.; Abe, H.; Terumichi, Y.; Tanaka, S. (Kyoto Univ.). Phys. Lett.; 32A: 283-4(27 Jul 1970).

Experimental results are presented for a repelling of electron-beam drifting along an increasing magnetic field by the local electron cyclotron resonance with the nonuniform static magnetic and high-frequency fields. (auth)

42670 OBSERVATION OF INDUCED COMPTON SCATTERING IN LASER-CREATED PLASMA. Decroisette, M.; Piar, G.; Floux, F. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Phys. Lett.; 32A: 249-50(27 Jul 1970). (In French).

The induced Compton scattering of an electromagnetic wave in a plasma is experimentally observed. The inverse form of this experiment was suggested in 1933 by Kapitza and Dirac. (auth)

42671 STUDY OF RELAXATION EFFECTS BEHIND SHOCK FRONTS GENERATED THROUGH PLASMA-FLOW INTERACTION WITH LARGE MAGNETIC FIELDS. Zimmermann, W.; Willeke, K.; Muntenbruch, H.; Steffes, B. (Institut fuer Plasmaphysik, Garching, Ger.). Phys. Lett.; 32A: 225-6(27 Jul 1970).

Spectroscopic investigations of reflected luminous fronts, generated through plasma flow interactions with large magnetic fields show a gradual increase of electron density. Streak interferometric observation of a separate reflected shock front allows this to be interpreted as ionization relaxation. (auth)

42672 ELECTRON CYCLOTRON RESONANCE AND THE DETECTION AND SPECTRAL RESOLUTION OF FAR-INFRARED RADIATION. Robinson, L. C. (Univ. of Sydney). Infrared Phys.; 10: 111-23(Jun 1970).

It is shown that the particle energy perturbation in a short-duration interaction between a weak radiation field and a system of free electrons in cyclotron motion about a homogeneous magnetic field can be observed. The interaction offers a means of radiation detection with the characteristics of a tunable high-resolution spectrometer. With high magnetic fields the process has particular significance to the far-infrared spectral region. In this context a practical system is proposed and analysed. (auth) (UK)

42673 CONTROL OF ION-ENERGY DISTRIBUTION IN A BACK-DIFFUSION TYPE PLASMA. Kawai, Y.; Ikegami, H. (Nagoya Univ., Japan). Phys. Lett.; 32A: 318-19(10 Aug 1970).

A new type of plasma, back-diffusion type plasma, is studied, where the energy distribution of the streaming ions is controlled in the drift velocity as well as in its energy spread. (auth)

42674 PRODUCTION OF ION STREAM COMPOSED OF TWO COMPONENTS IN VELOCITY DISTRIBUTION. Honzawa, T. (Nagoya Univ., Japan). Phys. Lett.; 32A: 335-6(10 Aug 1970).

A new experimental method of producing an ion stream composed of two components in velocity distribution with a diffusion-type plasma source is described. The energies and relative intensities of the two components can be controlled at will. (auth)

42675 THETA-PINCH PLASMA GUN FOR HIGH-BETA INJECTION. Turner, R. (Johns Hopkins Univ., Silver Spring, Md.). Phys. Fluids; 13: 2398-2406(Sep 1970).

A small theta-pinch plasma gun using two independently energized pinch coils was developed to study the interaction of a high-beta plasma with magnetic fields. The gun produces a doughnut-shaped puff of hydrogen plasma which, in a 2.1 kG longitudinal magnetic (B_z) field, has a density of $1 - 2 \times 10^{15}$ cm^{-3}, a temperature of 35 eV, and a directed energy of 210 eV. The transverse energy of the puff, limited by flute instabilities during the initial compression phase and entry into the B_z field, is more than three times as large as the output from a more conventional, but comparable, conical gun. A significant amount of the directed plasma energy can be converted to transverse energy by reflecting the plasma from a magnetic barrier. (auth)

42676 EXPERIMENT ON THE INTERACTION BETWEEN A PLASMA AND A NATURAL GAS. Danielsson, Lars (Royal Inst. of Tech., Stockholm). Phys. Fluids; 13: 2288-94(Sep 1970).

In an experiment where a high velocity plasma stream penetrates a stationary neutral gas cloud in a magnetic field, it is found that the interaction between the plasma and the gas is far more violent than what can be expected from simple atomic interaction theories. The parameters are such that the character of the interaction is collisionless. The observations demonstrate that the plasma is very efficiently retarded as it penetrates into the gas cloud and that the electron energy distribution changes drastically towards higher energies, at least for a part of the population, resulting in partial ionization of the gas. In order to account for the observations it is necessary to assume some kind of collective interaction between the plasma and the neutral gas. The results are analyzed from the point of view of Alfvén's critical velocity hypothesis. (auth)

42677 EXPERIMENTAL STUDY OF A PLASMA FLOW IN A MAGNETIC NOZZLE. Kuriki, Kyoichi; Okada, Osami (Tokyo Univ.). Phys. Fluids; 13: 2262-9(Sep 1970).

Interaction between an axisymmetric jet of plasma and a magnetic field generated by concentric current loops is studied experimentally. With a large Hall parameter, electrons are confined to the converging–diverging lines of force. The maximum Hall parameter for electrons is greater than 30. Measurements are made of the electric potential, ion density, electron temperature, and ion velocity. The flow of charged particles is found to be aligned with the magnetic lines of force with a slip relative to neutral atoms. The ion is compressed electromagnetically and is pumped to flow over a potential barrier formed near the center of the coil. The maximum velocity of ions at the exit of the magnetic nozzle is greater than that expected from an isentropic expansion. This extraordinary speed of ions is accounted for in terms of the electrostatic acceleration. In the magnetic channel the energy equation for ions is coupled with the energy equation for electrons. (auth)

Kinetics (Theoretical)

Refer also to abstract 43043.

42678 (NP-18341) TRANSPORT PROCESSES IN TOROIDAL MAGNETIC TRAPS. II. TRANSPORT PROCESSES IN WEAKLY IONIZED PLASMA. Preprint No. 56. Kovrizhnykh, L. M. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1970. 71p. (In Russian). Dep. CFSTI (U. S. Sales Only).

For the case of weakly ionized plasma, expressions were obtained for particle and energy fluxes across the magnetic field in toroidal magnetic traps of various types (Tokamak, levitron, and stellarator) for a wide range of plasma and magnetic-field parameters. (tr-auth)

42679 (UCRL-Trans-10470) INTERACTION OF RELATIVISTIC ELECTRON BEAMS WITH PLASMA. THE PROBLEM OF CRITICAL CURRENTS. Bogdankevich, L. S.; Rukhadze, A. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated by A. Karamazov for Univ. of California, Lawrence Radiation Lab., Livermore, from Russian Preprint No. 6. 62p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 28248. (M.O.W.)

42680 TRANSIENT RELAXATION OF VELOCITY DISTRIBUTION FUNCTION OF ELECTRONS FOR WEAKLY IONIZED PLASMAS. Ghatak, A. K.; Chakravarti, A. K.; Rattan, I. (Indian Inst. of Tech., New Delhi). J. Phys., D (London); 3: L30-4(Aug 1970).

Relaxation of the velocity distribution function of electrons for weakly ionized plasmas subjected to pulsed dc signals, for an arbitrary velocity-dependent collision frequency, is investigated. (auth) (UK)

42681 FROZEN PROPERTIES AND CUTOFF CRITERIA OF HIGH-TEMPERATURE GASES. Capitelli, M.; Ficocelli, E. (Univ., Bari, Italy). Z. Naturforsch.; 25a: 977-9(Jun 1970).

The importance of the contribution coming from electronic excitation for the evaluation of the "frozen" properties of a plasma and the strong dependence of the electronic contribution on the adopted cutoff criterion are shown. (auth)

42682 DERIVATION OF THE FREE ENERGY OF QUANTUM PLASMA OF LOW DENSITY FROM THE EXACT SCATTERING PHASE. Ebeling, W. (Univ., Rostock, Ger.). Ann. Phys. (Leipzig); 22: No. 1-2, 33-9(Nov 1968). (In German).

A statistical derivation is given of a general explicit formula for the free energy of low-density plasmas, which was proposed in an earlier paper. Starting from the cluster expansion of the free energy of quantum plasmas, the generalized second virial coefficient is expressed in terms of the two-particle scattering phase shifts, which are exactly known in the case of Coulomb interactions. The second virial coefficient is represented in the form of a convergent series expansion in terms of the Born interaction parameter $\xi = (e^2/kT\lambda)$, where λ is the thermal De Broglie wavelength. (auth)

42683 LINEAR RESPONSE THEORY OF LONGITUDINAL PLASMA EXCITATIONS. Turski, A. J. (Monash Univ., Clayton, Australia). Ann. Phys. (Leipzig); 22: 180-200(Jan 1969).

The plasma convolution equation equivalent to the initial problem of linearized Boltzmann–Vlasov and Poisson's equations of an isotropic, one-dimensional and nonrelativistic plasma is derived. The integral equation obtained involves both the time t and space coordinate x. The solution of this equation is exhibited in terms of a forcing function and a resolvent kernel. The forcing function is an exciting electric field caused by the initial disturbance of plasma equilibrium. The resolvent kernel obeys an integral kernel equation which also involves the kernel of the convolution plasma equation and the resolvent is interpreted as a plasma response to the unit impulse disturbance. The plasma kernel is directly expressed by the equilibrium velocity distribution. The plasma response and the equilibrium distribution are related in the same way as the response of a transmission line is related to its transfer function and the integral-kernel equation plays a key role in the formulation of problems of plasma analysis and synthesis. To analyze plasma is to determine its electric response for a given equilibrium velocity distribution of plasma components and to synthesize plasma is to design an equilibrium distribution of plasma components for a required plasma response. The plasma analysis is carried out and the example of Lorentzian and Maxwellian plasma equilibrium distributions is considered The plasma convolution equation equivalent to the one-point boundary problem, (x = 0), of linearized Boltzmann–Vlasov and Poisson's equations is presented. The absence of discrete spectrum solutions is evident from the plasma convolution equations but the oscillation properties of plasma are preserved for the examples considered. The complete analytical results are obtained for a Lorentzian plasma. The electric response of the plasma is shown to be a temporal oscillation traveling with the velocity $U = x/t$ and the amplitude of the traveling oscillation depending on U and decaying as t^{-1}. For a Maxwellian plasma the asymptotic expansion of the electric response is obtained for short and long times and a fixed x. The result for the short-time limit is the same as in the Lorentzian plasma case and for the long-time approximation the plasma response is shown to be an oscillation decaying as $t^{-3/2}$. (auth)

42684 SOLUTION OF THE TRANSITION RADIATION PROBLEM FOR A PLASMA PLATE. Elbakyan, S. S. (Erevan Inst. of Physics). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 5: 29-40 (1970). (In Russian).

The problem of transition radiation in a plasma plate in vacuum is solved, assuming that the reflection of plasma electrons from plasma–vacuum boundary is a mirror one. The radiation fields in vacuum and the field in the medium are obtained. A particular case of weak spatial dispersion is discussed. (auth)

42685 CALCULATION OF THE SPECTRA OF STATIONARY PLASMA TURBULENCE. Makhankov, V. G.; Zhidkov, E. P.; Tsytovich, V. N.; Che Ze Hen (Joint Inst. for Nuclear Research, Dubna, USSR). Plasma Phys.; 12: 191-201(Mar 1970).

Stationary electrostatic plasma turbulence is considered. By introducing a continuous parameter the stationary spectrum of the turbulence is found by means of a computer. The numerical results obtained are compared with analytical results obtained for an asymptotic region of wave numbers. The method of solution is described. Prospects for further investigation in this field are considered. (auth) (UK)

42686 STEADY FLOW IN THE AXIALLY SYMMETRIC TORUS USING THE GUIDING-CENTER EQUATIONS. Dobrott, D.; Greene, J. M. (Princeton Univ., N. J.). Phys. Fluids; 13: 2391-7(Sep 1970).

General steady flow in an axially symmetric torus is investigated using the guiding-center equations. Several constants of the macroscopic and microscopic motion are obtained, and a second-order quasi-linear partial differential equation is derived for the self-consistent magnetic flux function. The condition specifying that this equation be hyperbolic or elliptic is given. For the former case, jump conditions are given when weak (discontinuous) solutions are admitted. (auth)

42687 THEORY OF SELF-DIFFUSION IN CLASSICAL FLUIDS: THE VAN HOVE SELF-CORRELATION FUNCTION $G_s(r,t)$. Akcasu, A. Ziya (Cekmece Nuclear Research Center, Istanbul, Turkey); Corngold, Noel; Duderstadt, James J. Phys. Fluids; 13: 2213-21(Sep 1970).

Projection operator techniques were applied to study the diffusion of a test particle in a classical many-particle system such as a liquid or a plasma. Particular attention was directed towards the calculation of the Van Hove self-correlation function $G_s(r,t)$. This calculation proceeds through the development of exact descriptions of $G_s(r,t)$, both in configuration space (analogous to generalized hydrodynamic equations) and phase space (kinetic equations) which are then suitably approximated and solved using either perturbation or modeling methods. These results compare quite favorably with molecular dynamics computer experiments. (auth)

42688 PARTICLE MOTION IN THE PRESENCE OF THREE-DIMENSIONAL FINITE AMPLITUDE HARMONIC CYCLOTRON WAVES. Aamodt, R. E. (Univ. of Colorado, Boulder). Phys. Fluids; 13: 2341-7(Sep 1970).

The motion of charged particles in six-dimensional phase space is investigated when the particles are influenced by a strong uniform magnetic field and finite amplitude electric fields with frequencies at or near a harmonic of the cyclotron frequency. In general, it is found that the particles move in a vortex filament pattern in this six-dimensional phase space. Using the constraint of this motion the amount of energy available to go into electric field energy is estimated for a loss-cone distribution function with several assumed simple types of three-dimensional wave forms. It is found that only a small fraction of the particle kinetic free energy can go into waves. (auth)

42689 NONADIABATIC HARMONIC OSCILLATOR. Howard, James E. (Princeton Univ., N. J.). Phys. Fluids; 13: 2407-12 (Sep 1970).

Nonadiabatic changes in the action integral are estimated for the special case of even $\omega(t)$ by using a steepest-descent method to evaluate an integral of Vandervoort. The results are found to be in good agreement with a numerical example. (auth)

42690 NONLINEAR DEVELOPMENT OF THE BEAM–PLASMA INSTABILITY. Drummond, W. E. (Univ. of Texas, Austin); Malmberg, J. H.; O'Neil, T. M.; Thompson, J. R. Phys. Fluids; 13: 2422-5(Sep 1970).

The nonlinear limit of wave growth induced by a low-density cold electron beam in a collisionless plasma is calculated from a simple physical model. The bandwidth of the growing "noise" is so small that the beam interacts with a nearly sinusoidal electric field. (auth)

42691 TRANSPORT COEFFICIENTS OF INHOMOGENEOUS PLASMAS IN A MAGNETIC FIELD. Yoshikawa, S. (Princeton Univ., N. J.). Phys. Fluids; 13: 2300-7(Sep 1970).

Transport coefficients of inhomogeneous, magnetized plasmas are derived using the quasi-linear approximation. It is shown that mechanisms which allow the motion of ions across the magnetic field, such as ion–neutral collisions, are essential in arriving at divergent-free, finite transport coefficients in unbounded plasmas. The transport coefficients are calculated for both unbounded and bounded plasmas. Although in toroidal plasmas the transport coefficients do not follow the 1/B law, the calculated diffusion coefficients are numerically very close to what is known as the Bohm diffusion coefficients in a number of experimental devices. (auth)

42692 TURBULENT PLASMAS IN A MAGNETIC FIELD: A STATISTICAL THEORY. Weinstock, Jerome (Environmental Science Services Administration, Boulder, Colo.). Phys. Fluids; 13: 2308-16(Sep 1970).

A statistical theory of plasma turbulence in a magnetic field is described. This theory makes use of averaging operators to formally solve the Vlasov equation and the stochastic acceleration problem. Sets of turbulence equations are thereby derived for determining the ensemble average of the one-particle distribution functions and the electric field spectrum. The average distribution function is seen to satisfy a diffusion equation to all orders in the perturbation—even in the presence of a magnetic field. The mentioned equations are used to derive a nonlinear dispersion relation for waves in turbulent plasmas in a magnetic field. This dispersion relation is a nonlinear generalization of Bernstein's linear dispersion relation for electrostatic waves. The nonlinearity manifests itself as a damping factor proportional to mean square deviations from mean particle trajectories. A simplifying feature of the present work is the use of cumulant expansions, which also avoid certain heuristic arguments. A previous result, given by Dupree, is shown to be a special case of the present result. (auth)

42693 ION ACOUSTIC SHOCK WAVES. Biskamp, D.; Parkinson, D. (European Space Research Inst., Frascati, Italy). Phys. Fluids; 13: 2295-9(Sep 1970).

The one-dimensional hydrodynamic equations for an ion–sound system (cold ions, isothermal massless electrons) are solved numerically to study the behavior of nonlinear ion–sound waves, in particular, the formation and interaction of shock waves. (auth)

42694 OBLIQUE SHOCKS IN FINITE-BETA PLASMAS. Crevier, W. F.; Tidman, D. A. (Univ. of Maryland, College Park). Phys. Fluids; 13: 2275-87(Sep 1970).

The structure of shock waves and solitons propagating oblique to a magnetic field in a warm plasma is analyzed. The calculations are based on two-fluid equations including resistive dissipation. A classification scheme for the various structures obtained as the shock speed and plasma parameters vary is given. The problem of high-Mach-number shock structure is also discussed. (auth)

42695 INTEGRAL EQUATION FOR INDUCTION OF MAGNETIC FIELDS IN FLOW OF DISSIPATIVE PLASMA. Kalikhman, L. E. Dokl. Akad. Nauk SSSR; 190: 1305-7(21 Feb 1970). (In Russian).

There is a correlation between the magnetic field and the field of the mean mass velocity of the flow of plasma; this is represented by the simplest integral of the differential equation of induction, involving also the pulse transfer process. The induction equation for a plasma with constant magnetic viscosity was transformed under consideration of the Maxwell equation and the continuity equation for imcompressible plasma. Using substitution for the pulse transfer equation, the total pressure consisting of the sum of hydrodynamic and magnetic pressures was derived. It was shown that when the magnetic Prandtl number is equal to one and there is no gradient in the total pressure, the electric currents generated in the plasma create a magnetic field which, like the solidified plasma field, is determined only by the velocity of the plasma, regardless of the presence of dissipative processes. The integral obtained may be applied generally for induction of both stationary and nonstationary plane and spatial plasma currents at any orientation of the magnetic field. (TTT)

42696 STRUCTURE OF COLLISIONLESS WAVES. Fedele, James B. (Cornell Univ., Ithaca, N. Y.). J. Plasma Phys.; 3: 673-89(Dec 1969).

Small-amplitude waves and collisionless shock waves are investigated within the framework of the first-order Chew–Goldberger–Low equations. For linearized oscillations, two modes are present for propagation along an applied magnetic field. One is an acoustic type that contains no finite Larmor radius effects. The other which contains the "fire hose" instability in its lowest order terms, does possess finite Larmor radius corrections. These corrections, however, do not produce instabilities or dissipation. There are no finite Larmor radius corrections to the single mode present for propagation normal to the applied magnetic field. Normal shock structure is investigated, but it is shown that jump solutions do not exist. An analytic solitary pulse solution is found and is compared with the Adlam–Allen pulse solution. (auth)

42697 COLLISIONLESS SHOCK IN A PLASMA WHICH IS ALMOST STABLE. Smith, A. (Univ. of the West Indies, Jamaica). J. Plasma Phys.; 3: 525-41(Dec 1969).

The possibility of a collisionless shock in a plasma not subject to electrostatic instabilities nor immersed in a permanent magnetic field was investigated. The equations governing a steady shock in an electron–ion plasma were deduced and their limitations are discussed. Attention is given to the fact that the velocity distribution in a collisionless plasma may not be Maxwellian. This yields a parameter which is a measure of high-energy particle density. It is found that almost always no steady shock exists. The inverse of the electron plasma wave-number $k_0 = \omega_p/c$ provides a scale length for the shock, though the dampening effect of the ions indicates a shock thickness much in excess of k_0^{-1}. It is concluded that the mechanism for such shocks may be important in a gas such as the solar wind. (auth) (UK)

42698 PERTURBATION OF MAGNETIC SURFACES IN A ROTATING HIGH-β TOROIDAL PLASMA. Dobrowolny, M.; Kovrizhnykh, L.; Pellat, R. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev. Lett.; 25: 639-40(7 Sep 1970).

In a toroidal resistive plasma in the presence of a radial electric field one can obtain large perturbations of magnetic surfaces when the frequency of the azimuthal plasma rotation approaches the Alfvèn frequency. (auth)

42699 JUMP RELATIONS FOR SHOCKS IN AN ANISOTROPIC MAGNETIZED PLASMA. Neubauer, Fritz Manfred (Inst. fuer Geophysik und Meteorologie, Brunswick). Z. Phys.; 237: 205-23 (1970).

The jump relations for shocks moving into a collison-free anisotropic magnetized plasma are investigated under the assumption of isotropy of the plasma behind the shock front. The plasma ahead of the shock is assumed to be stable against the fire-hose instability and the mirror instability. In order to facilitate comparison with the work of Bazer and Ericson on isotropic shocks our nomenclature has been adapted to theirs. It turns out that, as in the case of isotropic shocks, the density ratio can be at most 4, corresponding to $\gamma = 5/3$, that the change in magnetic field is bounded, and that except for the case of Alfvén shocks, the transverse parts of the magnetic field are collinear. It is further shown that the influence of the anisotropy is greatest for nearly equal thermal and magnetic energy densities. In the case of negative anisotropy, no compressive shocks are possible with a major decrease in magnetic field if the thermal energy density much exceeds the magnetic energy density. A new kind of shock is shown to result from the analysis, the major effect of which is to destroy the anisotropy with only small changes in density, magnetic field, and velocity vector. Its propagation speed is unbounded. Furthermore, it has turned out that compressive, magnetic-field-increasing shocks have lower bounds in the density jump and magnetic field change for negative and positive anisotropy, respectively. In the collision-free case no unique entropy condition depending only on the total pressure components and densities can be given before the solution of the problem of shock structure. Therefore, even expansive shocks may be admissible. The applicability of the isotropy assumption and ad-hoc assumptions of other authors are briefly discussed. (auth)

Production

42700 (MATT-786) PRODUCTION OF PLASMAS BY LONG-WAVELENGTH LASERS. Dawson, John M. (Princeton Univ., N. J. Plasma Physics Lab.). Jun 1970. Contract AT-(30-1)-1238. 6p. (CONF-700615-1). Dep. CFSTI.

From 3rd Fluid and Plasma Dynamics Conference, Los Angeles, Calif.

The possibilities of applying long-wavelength lasers, in particular the 10-μ CO_2 laser, to the problems of controlled thermonuclear reactions are considered. Radiation at wavelengths of 10 μ or longer can effectively heat plasmas to temperatures in the keV range at densities that can be confined by available magnetic fields. Such lasers would be a versatile tool for producing experimental plasmas and might provide plasma for a reactor. The physics of producing plasmas by this means as well as some possible devices is considered. (auth)

42701 IMPROVEMENTS IN OR RELATING TO RECTANGULAR PULSE GENERATORS. Ahrweiller, Michel (to Commissariat a l'Energie Atomique). British Patent 1,202,037. 12 Aug 1970. Priority date 23 Nov 1966, France.

A generator for producing rectangular electrical pulses was designed for the purpose of ionizing gases. A description of the circuit and its operation is given. (M.O.W.)

42702 LASER HEATING OF PLASMAS FOR PRODUCTION OF CONTROLLED THERMONUCLEAR REACTIONS. Ahlstrom, Harlow G.; Amherd, Noel A.; Steinhauer, Loren C.; Vlases, George C. Trend Eng.; 22: No. 3, 3-7(Jul 1970).

The theory of laser heating of magnetically confined plasmas and laboratory experiments designed to investigate the basic laser–plasma interaction physics are described. The construction of these experiments is now under way in the Aerospace Research Laboratory. (M.O.W.)

42703 FUNDAMENTAL STUDIES OF CESIUM PLASMA. Yamabe, Chobei; Sakagami, Yukio (Nara Technical Coll., Yamato, Japan). Nara Kogyo Koto Senmon Gakko Kenkyu Kiyo; No. 5, 77-81(Mar 1970).

The following were experimentally studied: production of quiescent plasma by use of thermal ionization, which is different from the production by the electrical discharge; determination of plasma parameters by probe-measurement methods; and analysis of how the plasma parameters change when a magnetic field is applied axially along a glass tube to prevent plasma particles from diffusing in radial directions. (auth) (Japan)

42704 EXACT SOLUTION OF RATE EQUATIONS FOR AFTERGLOW WITH AMBIPOLAR DIFFUSION AND ELECTRON ATTACHMENT. MacCallum, Crawford J. (Sandia Labs., Albuquerque, N. Mex.). Plasma Phys.; 12: 143-8(Mar 1970).

The system of three coupled differential rate equations governing the growth and decay of positive and negative ion and electron concentrations in an afterglow with ambipolar diffusion and electron attachment is solved in the sense of reducing the problem to the

solution of a singic algebraic (albeit transcendental) equation. Exact numerical solutions of this algebraic equation are defined in terms of iterative sequences (easily evaluated with desk calculator) which can be used to confirm the approximate analytical solutions or to improve them in the neighborhood of t_d. A numerical example is worked out. (auth) (UK)

42705 PREIONIZATION FOR COLLISIONLESS SHOCK WAVE EXPERIMENTS BY MEANS OF PHOTOIONIZATION. Keilhacker, M. (Institut fuer Plasmaphysik GmbH, Garching, Ger.); Pecorella, F.; Vlases, G. C. Phys. Fluids; 13: 2253-61 (Sep 1970).

Strong ultraviolet radiation emitted from a dynamically filled linear z-pinch in xenon is used to ionize low-density molecular hydrogen and the noble gases. The technique produces a homogeneous, current free initial plasma with electron densities of 10^{12} to 5×10^{13} cm^{-3} and temperatures of about 1 eV suitable for collisionless shock wave experiments. The degree of ionization which can be achieved at the center of a 150-cm-long test chamber having one light source at each end ranges at 1 mtorr filling pressure from 20% in H_2 to 60% in zenon. The absorption of capacitor bank energy by the z pinch and the radiation emitted are estimated. The calculation shows, in agreement with the experimental results, that zenon produces a much higher ionization rate than hydrogen. To get a picture of the space–time dependence of density, electron temperature, and ion temperature in the photoionized gas, the relevant set of coupled differential equations is solved numerically. The calculations show that for conditions resembling those of the experiment the energy equipartition time between electrons and ions can be made shorter than the times for radial diffusion and heat conduction by superimposing an axial magnetic field on the order of 100 G. (auth)

Stability

Refer also to abstracts 42725 and 42726.

42706 (LA–4482) NUMERICAL SIMULATION OF THE WEIBEL INSTABILITY IN ONE AND TWO DIMENSIONS. Morse, R. L.; Nielson, C. W. (Los Alamos Scientific Lab., N. Mex.). Apr 1970. Contract W-7405-eng-36. 21p. Dep. CFSTI.

A Particle-In-Cell simulation method for doing full electromagnetic simulations of collisionless plasma phenomena is described and applied to the Weibel instability in one and two dimensions. Magnetic particle trapping and subsequent mode coalescing are seen. Total magnetic field energy is seen to increase after initial instability saturation in one-dimensional cases but to decrease in two dimensions. (auth)

42707 STABILIZATION OF THE TRAPPED-PARTICLE MODE BY A COOL PLASMA COMPONENT. Liu, C. S. (Gulf General Atomic Inc., San Diego, Calif.). Contract AT(04-3)-167. Phys. Lett.; 32A: 244-5(27 Jul 1970).

The stabilizing effect of a relatively cool plasma component on the trapped-particle instability is investigated. For Tokamak parameters with two temperature components ($T_h \approx 1$ keV, $T_c \approx$ 100 eV) of comparable density, the trapped-particle mode is effectively stabilized. (auth)

42708 ELECTROSTATIC MARGINAL STABILITY OF A ONE-DIMENSIONAL INHOMOGENEOUS FINITE PLASMA. Santini, F. (EURATOM–FOM, Jutphaas, Netherlands). Plasma Phys.; 12: 165-73(Mar 1970).

The marginal stability of an inhomogeneous finite plasma, at equilibrium with an electric field, is investigated for linear electrostatic perturbations with a time dependence $e^{-i\omega t}$. A set of equilibria with a variable parameter is introduced, which equilibria, as well as their perturbations, should only depend on a single inhomogeneity variable. The perturbed electric field should vanish at the boundaries. The paper concerns the instability of equilibria in the vicinity of a marginal one admitting an $\omega = 0$ mode. The corresponding growth rate is derived explicitly in the case of special properties of the marginal equilibrium. A corresponding example is discussed. (auth) (UK)

42709 QUASI-ELECTROSTATIC MODES IN AXISYMMETRIC TORI. Kim, In Kyu; Malik, S. K. (Univ. of Wisconsin, Madison). Phys. Fluids; 13: 2385-90(Sep 1970).

The effect of the magnetic perturbations on the drift instabilities in the axisymmetric tori is studied. The dispersion relations and growth rates are calculated for the various frequency ranges of physical interest. An unstable mode exists for which the characteristic frequency of the oscillations ω is greater than the electron bounce frequency ω_{be}. This instability can be suppressed by the average favorable curvature. For the case, $\omega_{be} > \omega > \omega_{bi}$, the drift ballooning and drift universal modes are far more unstable than in the electrostatic case. The oscillations are always electrostatic for $\omega < \omega_{bi}$. (auth)

42710 GENERALIZED BOUNDARY CONDITIONS. Lindman, E. L. (Univ. of Texas, Austin). Phys. Fluids; 13: 2367-71(Sep 1970).

The concept of the generalized boundary condition is introduced, and stabilization of ion–sound waves and drift waves using such boundary conditions is demonstrated. The boundary consists of a two-dimensional, lumped-parameter transmission line in electrical contact with the plasma. A boundary dispersion relation is introduced which describes the boundary modes and their interaction with the plasma. Modes which are combinations of plasma and boundary modes are obtained which can be stabilized by appropriate choice of inactive circuit elements. (auth)

42711 INFLUENCE OF A RADIAL ELECTRIC FIELD ON STABILITY OF A MAGNETICALLY CONFINED PLASMA. Nocentini, A. (Univ., Trieste, Italy. CNEN, Frascati, Italy). J. Plasma Phys.; 3: 559-65(Dec 1969).

A magnetically confined, slightly nonuniform and nonneutral plasma column is considered. The existence is shown, in plane, infinite geometry, of a mode whose characteristic properties agree with those of an unstable wave detected in a recent experiment. (auth) (UK)

42712 RAYLEIGH–TAYLOR INSTABILITY IN HYDROMAGNETICS WITH FINITE ELECTRICAL RESISTIVITY AND HALL CURRENT. Singh, Surindar; Tandon, J. N. (Univ. of Delhi). J. Plasma Phys.; 3: 633-42(Dec 1969).

The effect of Hall current and finite electrical resistivity on the Rayleigh–Taylor instability of superposed incompressible fluids was studied in the presence of a uniform horizontal magnetic field. It was found that Hall current has a negligible stabilizing influence in the high-resistivity limit, whereas it has a destabilizing influence in the low-resistivity limit. (auth) (UK)

42713 TWO-STREAM INSTABILITY IN THE RESONANCE MODEL. Infeld, E.; Skorupski, A. (Inst. of Nuclear Research, Warsaw). J. Plasma Phys.; 3: 643-9(Dec 1969).

The problem of stability of two hot collisionless streams of charged particles is considered. The masses, charges, densities, and temperatures are arbitrary and the distribution functions are modelled by one "resonance" function for each stream. The problem of stability is resolved by Nyquist diagrams, and, for the case of equal plasma frequencies, also by solving the dispersion relation in ω. A comparison with two Maxwellians on the one hand, and a two-step function model on the other, is given. Step functions appear to be too crude for this problem. (auth) (UK)

Thermonuclear Processes

42714 (LA–4352) PROPOSAL FOR A SHOCK-HEATED TOROIDAL Z-PINCH EXPERIMENT. Phillips, James A. (Los Alamos Scientific Lab., N. Mex.). Nov 1969. Contract W-7405-eng-36. 8p. Dep. CFSTI.

A shock-heated toroidal z-pinch experiment is proposed in which a plasma temperature of ~1 keV is anticipated. The fast rising z current is driven by a magnetic energy storage system similar to that successfully used in a linear experiment. (auth)

42715 SHAFRANOV'S TYPE EQUILIBRIUM CONFIGURATION OF A FINITE β TOROIDAL PLASMA. III. Matsuura, Kenya (Electrotechnical Lab., Tokyo). Denki Shikensho Iho; 34: 203-17(1970).

An MHD equilibrium configuration of Shafranov's (screw) type for a finite-β toroidal plasma is investigated with a "single-layer model" in which the system is not divided into two regions, the region of the plasma column and the vacuum region surrounding the column. When the dependences of the plasma pressure and the toroidal magnetic field on stream function Ψ in an equilibrium equation are assumed by functions of exponential types, one can obtain the equilibrium configuration, in which the main part plasma is separated by the vacuum-like field configuration from the wall, by using the single-layer model. (auth)

42716 LINEAR PLASMA CURRENT MULTIPOLE EXPERIMENT. Kowashimo, N.; Mori, S. (Japan Atomic Energy Research Inst., Ibaraki). Plasma Phys.; 12: 203-4(Mar 1970).

An experiment is described in which a linear version of a proposed plasma current multipole device is investigated, and a few of the plasma parameters of such a system were determined. Some time-resolved photographs of the discharge are presented. (UK)

42717 OPERATION OF STELLARATOR CYLINDRICAL CONVERTERS IN THE PRESENCE OF AN AXIAL CURRENT. Loktionov, Yu. M.; Sebko, V. P. At. Energ. (USSR); 28: 263-5(Mar 1970). (In Russian).

In studies on stellarators having the form of a racetrack it is necessary to convert magnetic surfaces of a definite type into a circular form on straight sections of the equipment. This operation is performed by a special device called a cylindrical converter whose effect on magnetic surfaces was investigated at various cross sections of a straight magnetic system consisting of longitudinal field coils, two helical windings with shortened cylindrical converters on the ends, and a central, current-carrying rod. The magnetic field configuration was investigated by using ring electron beams. Studies were carried out on four cross sections: 1) middle of the first spiral winding, 2) after the cylindrical converter at the exit of the first helical winding, 3) at the cylindrical converter of the second helical winding, and 4) the middle of the second helical winding. Photographs show that a triangular configuration of the magnetic surface is readily converted to circular form in the absence of axial current. On the other hand, it was found that in the presence of an axial current equal to one-fifth of the current in the coils, the magnetic structure is sufficiently stable that it cannot be changed to a circular form. Because of the poor operation of the cylindrical converters and rotation of the magnetic force lines under the effect of the axial current, the magnetic surface in the region of the second helical winding has a form significantly different from its initial form, and this behavior can lead to loss of particles from the trap. (TTT)

42718 EVIDENCE FOR NEUTRON PRODUCTION VIA ENHANCED RESISTIVITY IN A PLASMA FOCUS. Bernstein, M. J.; Hai, F. (Aerospace Corp., El Segundo, Calif.). Phys. Rev. Lett.; 25: 641-2(7 Sep 1970).

Intense neutron production in a plasma-focus discharge begins when the visible plasma light fades abruptly. This correlation is interpreted in terms of enhanced plasma resistivity that causes Ohmic heating and permits a rapid constriction of the discharge current distribution; the latter phenomenon leads to deuteron acceleration resulting in intense neutron production. (auth)

Wave Phenomena

42719 (EUR-CEA-FC-474) STUDY OF FLUCTUATIONS OF A HYDROGEN PLASMA BEGINNING WITH THEIR CORRELATION FUNCTIONS. DISPERSION RELATION. Bernard, M.; Briffod, G.; Gregoire, M.; Weisse, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1968. 15p. (In French). Dep. CFSTI (U. S. Sales Only).

A fine analysis of the properties of the fluctuations of a plasma can be done if it is observed that the fluctuating variables of the plasma (density, electric field, potential) are stationary random variables from which all statistical properties can be obtained: averages, correlations, correlation times, correlation lengths. It is shown that this method can be used experimentally to obtain the dispersion relations of the plasma fluctuations. The method used to obtain the dispersion relation from the correlation functions is shown and illustrated with results obtained on DAPHNIS. It is seen that the linear dispersion relations measured in the azimuthal and longitudinal directions make it possible to identify with precision the characteristics of the waves causing the fluctuations observed. On the contrary, in order to know if these waves are excited by instabilities caused by density gradient, electric field, electric field gradient, or a combination of these effects, complementary studies are necessary. (J.S.R.)

42720 (EUR-CEA-FC-541) GROWTH RATE OF ELECTROSTATIC WAVES IN AN ANISOTROPIC MEDIUM WITH OR WITHOUT COLD PLASMA. Jacquinot, J.; Leloup, C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr 1970. 29p. (In French). Dep. CFSTI (U. S. Sales Only).

The growth rates of electrostatic waves are calculated in an infinite homogeneous plasma composed of a hot anisotropic electron population represented by a Maxwellian distribution function with two temperatures and a cold plasma. The analysis is restricted to frequencies below the electron cyclotron frequency. A simplified analytical treatment and an exact numerical calculation are used to study the effect of various parameters: propagation angle, pressure anisotropy, hot and cold plasma densities. (tr-auth) (France)

42721 (NP-18351) WEAK NONLINEAR COUPLING BETWEEN ALFVEN AND SOUND WAVES IN A RESISTIVE PLASMA. Rijnhuizen Report 70-59. Schuurman, W. (European Atomic Energy Community. Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). May 1970. 12p. Dep. CFSTI (U. S. Sales Only).

The resonant energy transfer in a resistive plasma from a large-amplitude Alfvén wave to an Alfvén wave and a sound wave with small amplitudes is considered. For small times the small-amplitude waves can grow exponentially, while, as time progresses, the solution approaches an undamped sound wave and a stable, damped Alfvén wave. The behavior of the wave amplitudes as a function of time is given in some detail. (auth)

42722 (NP-18364) LONGITUDINAL PLASMA WAVES AND ZERO SOUND. Wood, Warren Preston (New South Wales Univ., Kensington (Australia)). 1969. 51p. Dep. CFSTI (U. S. Sales Only).

Thesis.

Aspects of longitudinal electron oscillations in a dilute plasma are considered. Collisional damping corrections to the Landau damping are derived to first order in the collision frequency by means of the Krook model collision term. A comparison is made between the predictions of this model and other approaches to the problem. (auth) (Australia)

42723 (SIT-3785-10) SPATIAL DAMPING OF LARGE AMPLITUDE PLASMA WAVES. Lee, A.; Schmidt, G. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). Dec 1969. Contract AT(30-1)-3785. 25p. (SIT-245). Dep. CFSTI.

The spatial damping of a large-amplitude plasma wave was studied to permit direct comparison with experimental data. Using both the quasi-linear treatment of Altshul and Karpman, and following exact particle trajectories of resonant particles as done by O'Neil for the temporal case, it was found that the spatial damping results are analogous to the temporal ones. Changing the nondimensional time t/τ and damping coefficient $\gamma_L\tau$ for the temporal case into the distance x/L and spatial damping coefficient $\Lambda_L L$ respectively, results in the spatial damping formula. Here $\tau = (m/eEk)_k$ is the linear Landau damping coefficient $\Lambda_L = \gamma_L/(\partial\omega)/(\partial k)$ and $L = \tau\omega/k$. Damping curves have been plotted for comparison with measured data. The validity condition of the spatial case, namely, $\Lambda_L L \ll 1$, is far more stringent than for the temporal one. (auth)

42724 (SIT-3785-11) ENERGY TRANSFER FROM A LARGE AMPLITUDE WHISTLER WAVE TO AN ELECTROSTATIC MODE BY TRAPPED PARTICLE INSTABILITY. Schmidt, G.; Palmadesso, P. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). Apr 1970. Contract AT(30-1)-3785. 10p. Dep. CFSTI.

It was shown earlier that, as a result of the oscillatory nature of trapped particles in whistlers, a large-amplitude whistler mode after a transient cyclotron resonance damping executes strongly damped amplitude oscillations and settles down finally to a state of constant-amplitude whistler mode. Here it is shown that, due to the resonant particles oscillating in the magnetic traps, this mode is subject to an electrostatic trapped-particle instability transferring energy from the transverse mode into a growing longitudinal mode. Dispersion relations are derived and analyzed. (M.O.W.)

42725 (UCB-34-P-128-11) FIRST QUARTERLY PROGRESS REPORT OF 1969 ON PLASMA RESEARCH, JANUARY 1-MARCH 31, 1969. (California Univ., Berkeley. Electronics Research Lab.). Contract AT(11-1)-34. 45p. Dep. CFSTI.

The research involved studying the physical and electromagnetic properties, stability, and radiation of high-temperature plasmas. A low-temperature plasma was used as an analogue to study the stability of high-temperature plasmas. The high-temperature plasma research facility consists of a 250,000-joule capacitor energy-storage bank and related control system. The bank serves either of two magnetic-mirror compression experiments which require peak magnetic fields in excess of 50,000 gauss. The low-temperature plasma facility is an alkali-metal vapor plasma device; it was used to study the stability of low-temperature plasmas in various magnetic field and plasma configurations in a density regime which approximates a number of features of a high-temperature plasma. Complementary to the experiments are a wide range of theoretical studies. Computer experiments in one, two, and three dimensions were used to study both many-body systems and nonlinear systems as initial-value problems; this form of simulation produced a number of results not obtainable analytically and prior to experimental observation. Other theoretical work included the dynamics of single particles and solution of linear dispersion relations. (M.O.W.)

42726 (UCB-34-P-128-12) SECOND QUARTERLY PROGRESS REPORT OF 1969 ON PLASMA RESEARCH, APRIL 1-

JUNE 30, 1969. (California Univ., Berkeley. Electronics Research Lab.). Contract AT(11-1)-34. 120p. Dep. CFSTI.

MAGNETIC MIRRORS—plasma drift wave properties in compression experiment
—ion velocity distributions in compression experiment
—plasma instabilities in, distribution functions for hot-electron
—plasma density and energy in compression experiment, (T)
PLASMA—wave propagation and properties in magnetic-mirror compression experiment, drift
—ion velocity distributions in magnetic-mirror compression experiment
—kinetic theory for clouds of, drag and diffusion coefficients for
—simulation of, space–time grid effects in, (T)
—kinetics of one-dimensional warm, correlation function for
—stability of hot-electron, distribution functions for, (T)
—diagnostics in magnetic-mirror compression experiment, density and energy, (T) (M.O.W.)

42727 SELF-EXCITED ION–ACOUSTIC WAVES GENERATED BY MEANS OF ELECTRON CYCLOTRON RESONANCE AND ITS STABILIZATION. Okamoto, Y.; Tamagawa, H. (Nagoya Univ., Japan). Phys. Lett.; 32A: 279-80(27 Jul 1970).

Self-excited ion–acoustic waves are observed in a plasma generated near electron cyclotron resonance by microwave power. They are stabilized when the plasma beam is transmitted through a cusped magnetic field. (auth)

42728 PLASMA OSCILLATIONS OF CHARGE CARRIERS IN A CONSTANT HOMOGENEOUS ELECTRIC FIELD. Kazaryan, E. M. (Erevan State Univ.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 5: 20-8(1970). (In Russian).

The influence of a constant homogeneous electric field on plasma oscillations is considered. It is shown that the change in plasma frequency as well as the appearance of a second branch in an electric field is conditioned by the dispersion law of nonparabolicity. The dependence of plasma frequency on the electric field is studied, and the nonparabolicity parameter is derived. The possibility of determining the nonparabolicity parameter by the electric reflection method is discussed. (auth)

42729 COMPRESSIONAL ALFVEN WAVE REFLECTION FROM A MAGNETIC CLIFF. Cramer, N. F.; Lehane, J. A.; May, R. M.; Paoloni, F. J. (Univ. of Sydney). Phys. Lett.; 32A: 307-8(10 Aug 1970).

The reflection of azimuthally symmetric compressional waves from a magnetic "cliff," in which cutoff is encountered, was observed and predicted by a theory in which the waves are assumed to propagate along the magnetic field lines. (auth)

42730 DISPERSION RELATIONS FOR WARM PLASMAS. Burman, R. (Univ. of Western Australia, Perth). Phys. Lett.; 32A: 310-11(10 Aug 1970).

Dispersion relations obtained from Grad's thirteen-moment approximation are compared with others obtained by expanding kinetic theory results. (auth)

42731 CROSS MODULATION OF SUPRALUMINOUS WAVES IN A ONE-DIMENSIONAL PLASMA. Lerche, I. (Univ. of Chicago). Plasma Phys.; 12: 175-89(Mar 1970).

It is shown that when electrostatic waves are "triggered" in a one-dimensional plasma by two initial disturbances, either at different places or times, there results a "long-time" cross-modulation field. This field has a component made up from the interaction of the supraluminous waves that are generated by the two initial pulses (phase speed exceeding c) which phase averages to zero nearly everywhere for "large" distances and "long" times. However, at specific places and at specific times, the cross-modulated field can phase average to a finite value. In this sense the cross-modulated field generated by supraluminous waves is an echo. Values of the parameters for astrophysical plasmas and laboratory plasmas are contrasted, and it is shown that, except for H I regions, construction of such echoes appears possible. (auth) (UK)

42732 TM_{010} RESONANT FREQUENCY OF A MICROWAVE CYLINDRICAL CAVITY PARTIALLY FILLED WITH A NON-UNIFORM PLASMA COLUMN SURROUNDED BY A GLASS CONTAINER. Rozkwitalski, Z. (Inst. of Fluid-Flow Machines, Danzig). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 18: 177-84 (1970).

The interaction between a nonuniform plasma column surrounded by a dielectric container and the TM_{010} field of a cylindrical cavity was analyzed. Analytical expressions describing the relation between the resonant frequency and a group of parameters representing the geometrical and physical properties of the plasma and the container are presented. These relations form the theoretical basis for working out the method of electron-density measurements of the plasma studied. As has been shown in examples of computer calculations, serious errors may arise, if both the density distribution and the influence of the dielectric container are not taken into consideration. (auth)

42733 PERTURBED ION DISTRIBUTIONS IN ION WAVES AND ECHOES. Ikezi, H.; Taylor, R. J. (Univ. of California, Los Angeles). Phys. Fluids; 13: 2348-52(Sep 1970).

The perturbed part of the ion distribution function is observed experimentally when an ion wave or ion-wave echo is excited in a plasma. In the case of the wave the perturbed distribution is confirmed to survive, as predicted by Landau, after the wave damps away. In the case of the ion-wave echo the features of the oscillations of the distribution function in velocity space are in agreement with the prediction of the perturbation theory carried to the second order. However the second-order perturbed distribution function, which is responsible for the formation of the echo, is observed to undergo a strong reduction in amplitude after the appearance of the echo electric field. (auth)

42734 COUPLING OF TRANSVERSE AND LONGITUDINAL WAVES IN A DRIFTING MAGNETOPLASMA. Hsieh, H. C. (Iowa State Univ., Ames). Phys. Fluids; 13: 2353-8(Sep 1970).

The coupling of transverse circularly polarized electromagnetic waves and longitudinal plasma waves in a collisionless drifting magnetoplasma is studied. A quasi-longitudinal propagation is considered. It is shown that the left-hand circularly polarized wave may be amplified by interacting with a slow space-charge wave, while a right-hand circularly polarized wave may be attenuated by interaction with a fast space-charge wave. The condition for amplifying the left-hand wave is given by $b > 1/(1 + \sigma^2)$, where $b = (\omega_p/\Omega_e)$, $\sigma = (u_{0_\parallel}/c)$, in which ω_p and Ω_e are the electron plasma and electron cyclotron angular frequencies, respectively. The symbol $u_{0_\parallel}$ is the drift velocity of plasma and c is the speed of light in a vacuum. The variation of the rate of growth or decay and the variation of phase velocity of the transverse electromagnetic wave with the parameters b, σ, and $\kappa = (B_{0_\perp}/B_{0_\parallel})$ are examined in detail. $B_{0_\perp}$ and $B_{0_\parallel}$ are the normal and parallel components of magnetostatic field, respectively. (auth)

42735 NUMERICAL SOLUTION OF DISPERSION EQUATION FOR A BI-MAXWELLIAN PLASMA. Kito, Masafumi (Electrotechnical Lab., Tokyo); Kaji, Ikuo. Phys. Fluids; 13: 2359-66 (Sep 1970).

In the presence of a uniform magnetic field, longitudinal oscillations of a plasma with a bi-Maxwellian distribution function are studied numerically. A dispersion equation which involves a function $Z(\zeta) = \pi^{-\frac{1}{2}} \int_{-\infty}^{\infty} dx [\exp(-x^2)/(x - \zeta)]$, where ζ is complex, is derived. A root of the equation is obtained by using a formula which combines the asymptotic expansion of $Z(\zeta)$ with the power series of $Z(\zeta)$. The real part of roots gives a mode of cold plasma oscillations and modes of multiple oscillations of the cyclotron frequency. These modes are coupled and hybrid modes exist. Instabilities arise along long strips which are along modes of multiple oscillations. If an anisotropy of the bi-Maxwellian distribution is constant, then instabilities are growing while the temperature of the plasma is increasing. (auth)

42736 SECOND-ORDER PERTURBED DISTRIBUTION ASSOCIATED WITH THE PLASMA WAVE ECHO. Nishkawa, Kyoji (California Inst. of Tech., Pasadena). Phys. Fluids; 13: 2420-2(Sep 1970).

The perturbed distribution, which contributes a plasma wave echo, shows an oscillatory behavior with different phases and amplitudes before and after the echo. The difference in amplitude is found to be negligibly small except for very special cases. (auth)

42737 GROWTH RATE CALCULATIONS FOR ELECTRON–ELECTRON MODES WITH PRESSURE ANISOTROPY AND COLD PLASMA. Jacquinot, J.; LeLoup, C. (CEN, Fontenay-aux-Roses, France). Phys. Fluids; 13: 2332-4(Sep 1970).

Maximum linear growth rates of electromagnetic and electrostatic waves in an infinite homogeneous plasma are compared for a large domain of physical parameters. The analysis is restricted to frequencies just below the electron cyclotron frequency. (auth)

42738 DRIFT WAVES IN A SLIGHTLY NON-NEUTRAL PLASMA. Nocentini, A. (Univ., Trieste, Italy. CNEN, Frascati, Italy). J. Plasma Phys.; 3: 543-57(Dec 1969).

The influence of the lack of neutrality on the drift instabilities (collisionless and collisional) of a nonuniform, isothermal plasma

is considered. It is shown that the local dispersion relation depends on the derivatives of the electric field present in the equilibrium of the nonneutral plasma. In particular the influence of the first two derivatives is discussed. (auth) (UK)

42739 STABILITY OF NONLINEAR PLASMA WAVES. Rowlands, G. (Univ. of Warwick, Coventry, Eng.). J. Plasma Phys.; 3: 567-76(Dec 1969).

The stability of a stationary nonlinear wave set up by two counter-streaming cold beams of electrons immersed in a background of stationary ions is examined without recourse to an expansion in terms of the amplitude of this wave. It is found that this wave is unstable to small perturbations and hence one would not expect such waves to exist in practice. (auth) (UK)

42740 NONLINEAR TRANSVERSE WAVES IN A VLASOV PLASMA. Gary, S. Peter (Univ. of St. Andrews, Scotland). J. Plasma Phys.; 3: 577-92(Dec 1969).

Nonlinear transverse waves in a classical nonrelativistic collisionless, Maxwellian electron gas with external magnetic field B_0 are considered. There is assumed a small, sinusoidal variation in the initial electric and magnetic fields, corresponding to excitation of a discrete wave-number mode. The nonlinear Vlasov equation is solved to second order in the long time limit via the Montgomery–Gorman perturbation expansion, and the time-independent, spatially homogeneous part of the second-order distribution function is used to modify the linear dispersion relation. For frequencies near the electron cyclotron frequency a nonlinear damping decrement results such that, for many values of the parameters, the damping is less than the linear rate. Thus at sufficiently long times, the rate of damping of transverse electron cyclotron waves should decrease, a result similar to that for nonlinear damping of longitudinal electron plasma waves. (auth) (UK)

42741 SMALL-AMPLITUDE TRANSVERSE WAVE PROPAGATION IN WEAKLY LANGMUIR-TURBULENT PLASMA. Bel, N.; Heyvaerts, J. (Institut d'Astrophysique, Paris). J. Plasma Phys.; 3: 593-601(Dec 1969).

The high-frequency conductivity tensor of an isotropic plasma is derived, taking into account particle correlations at the lowest consistent order in the parameter w_p/w; these correlations describe a weakly Langmuir turbulent plasma. Two special cases are investigated in which the two-particle correlation function is related to the turbulent electrostatic field spectrum. Particular distribution functions and spectra are considered and approximate dispersion relations are derived in both cases in "the cold plasma limit." The importance of the corrective term is discussed in terms of three dimensionless parameters measuring the strength of the turbulence, the shape of the spectrum, and the frequency. The effect could be important for frequencies not too far from the plasma frequency. (auth) (UK)

42742 SATURATION AND DAMPING OF COLLISIONLESS PLASMA WAVE ECHOES. Coste, J.; Peyraud, J. (Faculte des Sciences, Orsay, France). J. Plasma Phys.; 3: 603-10(Dec 1969).

When the intensity of the second applied pulse or the time interval is increased between the two pulses, the amplitude of the first echo saturates and multiple echoes of comparable amplitude appear. Moreover, a damping of the echoes due to a phase mixing effect is predicted. (auth) (UK)

42743 HOT PLASMA THEORY OF WHISTLER-MODE WAVE-PACKET PROPAGATION ALONG A NONUNIFORM MAGNETIC FIELD. Houghton, M. J. (Imperial Coll. of Science and Tech., London). J. Plasma Phys.; 3: 611-31(Dec 1969).

The dynamics of unstable wavepacket propagation are investigated in both uniform and nonuniform plasmas. The theory applied throughout is linear. The uniform plasma case is investigated and the emphasis is on the physical mechanisms that can effect changes in both phase and amplitude of the wave packet. The treatment gives some simple physical insight into the mode of the propagation of unstable wave packets in uniform media, when the regime is linear, and in the process it makes clear what phenomena the linear theory cannot be expected to account for. Also the investigation is helpful in understanding the nature of solutions which are derived where the ambient magnetic field is nonuniform. The ambient magnetic field is chosen so that the wave packet is propagating into regions of changing gyrofrequency. (auth) (UK)

42744 RELATIVISTIC EFFECTS ON NONLINEAR WAVES IN A COLD COLLISIONLESS PLASMA. Inoue, Yoshinori (Osaka Univ.). J. Plasma Phys.; 3: 661-71(Dec 1969).

Nonlinear periodic waves propagating across a magnetic field are investigated, taking relativistic effects into account. The governing equations of the phenomena are taken to be the relativistic two-fluid plasma equations for a cold plasma together with Maxwell's equations. The analytical solution in the nonrelativistic case was obtained by Adlam and Allen and others, a case where the quasi-neutral approximation is a good one and the inertia of the electrons plays an essential role in the dispersion effect of the plasma. In the present case where the electron mass may be neglected, there exists an exact solution which is a good approximation for a real plasma. The solitary wave solution is found as the limiting case of infinite periodicity. (auth) (UK)

42745 NORMAL MODES OF OSCILLATION IN A HIGHER-ORDER CHEW–GOLDBERGER–LOW PLASMA. Sisson, A. E.; Yu, C. P. (State Univ. of New York, Buffalo). J. Plasma Phys.; 3: 691-707(Dec 1969).

The low frequency, linear oscillation of an unbounded, homogeneous, low density plasma in the presence of a strong, uniform magnetic field is examined using a set of three-dimensional hydromagnetic equations derived from the higher-order Chew–Goldberger–Low theory recently obtained by Frieman, Davidson & Langdon (1966). It is found from the higher-order corrections to the dispersion relation that the waves are generally dispersed and the mirror and firehose instabilities are stabilized. (auth) (UK)

Shielding

Refer also to abstracts 41893 and 43728.

42746 (DP–1232) ESTIMATION OF ^{252}Cf SHIELDING REQUIREMENTS. Hootman, H. E. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr 1970. Contract AT(07-2)-1. 34p. Dep. CFSTI.

A method for estimating shielding requirements for ^{252}Cf is given in a series of curves showing neutron and gamma-ray dose rates for various shielding materials. A glossary of nuclear terms and a brief résumé of DOT radiation regulations are included. (auth)

42747 (ORNL-RSIC-25(Suppl.1)) SHIELDING BENCHMARK PROBLEMS. Profio, A. E. (ed.) (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 44p. (ANS-SD-9(Suppl.1)). Dep. CFSTI.

The Benchmark Problems Group of the American Nuclear Society Shielding Standards Subcommittee (ANS-6) has selected several "benchmark" problems for testing computational methods of radiation transport. Problems are described and solution data are presented. It is anticipated that publication of these problems will serve to focus attention so that careful work will produce solutions which are representative of the state-of-the-art. The problems will also serve to specify standard configurations so that meaningful comparisons can be made between different calculational methods and between experimental and calculational results. Supplement 1 provides an additional solution to a problem issued previously (neutron spectrum in graphite) and presents a new problem (nucleon–meson cascade in iron). (auth)

42748 (WAPD-T-2330) EFFICIENCEY OF LAGUERRE AND LEGENDRE QUADRATURES IN SHIELDING CALCULATIONS. Shure, K.; Swartz, L. M.; Wallace, O. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr 1970. Contract AT-11-1-GEN-14. 18p. (CONF-700608-19). Dep. CFSTI.

From American Nuclear Society Meeting, Los Angeles, Calif.

The accuracies of Laguerre and Legendre quadrature techniques for numerical integration of the exponential point kernel over a line source were evaluated. Results indicate that the relative efficiency of the Laguerre versus the Legendre technique is dependent on the location of the field point with respect to the integration interval. There are areas where the Laguerre technique is more efficient, but there are other areas such as those encountered in studies of axial and/or azimuthal variation of fluxes from cylindrical sources where the Legendre technique is more efficient. For volume integrals applying three one-dimensional quadratures, a combination of Laguerre and Legendre quadratures can be more efficient than exclusive use of either quadrature technique. (auth)

Solid-State Physics

Radiation Effects

Refer also to abstracts 42162, 42288, 42502, 42507–42509, 42511–42513, 42520–42523, and 42607.

42749 (CEA-R-4027) PLANAR CHANNELING OBSERVED BY RADIOGRAPHY. Delsarte, Guy (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1970. 110p. (In French). Dep. CFSTI (U. S. Sales Only).

Radiographies of crystals by means of channeled particles exhibit channeling patterns. The origin of these patterns is studied. The role played by planar channeling is demonstrated. These patterns are found to be local amplifications of the process generating the images of a crystal on the radiography. It is deduced that planar channeling plays a determining role in the formation of these images. The radiographic projection of a gold grain in the direction ⟨111⟩ and that of a copper grain in the direction ⟨100⟩ was studied. The planar channeling in tungsten and that of the fission fragments Au, Cu, W are investigated. An orientation chamber using transmitted planar channeling is described. The orientation of very small grains in a polycrystal can be very easily obtained. (tr-auth) (France)

42750 (COO-1105-158) STARK EFFECT OF THE M AND N CENTERS IN KCl, NaCl, AND LiF. DeWerd, L. A. (Wisconsin Univ., Madison. Dept. of Physics). [1968]. Contract AT(11-1)-1105. 18p. Dep. CFSTI.

The Stark effect on the M center in x-irradiated LiF and on the M and N centers in x-irradiated KCl and NaCl at 78°K was investigated. X-ray doses of 4×10^6 R and electric fields of $\sim 10^5$ V/cm were used. The data on LiF were reported previously (COO-1105-148) and are analyzed. (D.L.C.)

42751 (COO-1105-159) PRELIMINARY STUDIES OF THE EFFECTS OF FAST NEUTRONS ON THE OPTICAL PROPERTIES OF ANTHRACENE. Pearson, D. W.; Moran, P. R.; Cameron, J. R. (Wisconsin Univ., Madison. Dept. of Physics). [1968]. 7p. Dep. CFSTI.

The effects of 14-MeV neutrons and 30-keV (effective) x rays on the blue delayed fluorescence (fusion of two triplets to form a singlet that decays radiatively) of anthracene were measured at room temperature. The neutrons were found to be more effective in destroying the blue delayed fluorescence than the x rays. A plot of $(F_f)^{-\frac{1}{2}}$ vs dose revealed a linear relationship for x rays but not for neutrons beyond 200 R. (D.L.C.)

42752 (COO-1105-161) LOW TEMPERATURE THERMOLUMINESCENCE IN LiF. Podgorsak, Ervin B.; Cameron John R. (Wisconsin Univ., Madison. Dept. of Physics). [1969]. 19p. Dep. CFSTI.

The low-temperature thermoluminescence (TL) of LiF was investigated using x irradiation at 78°K and heating to several hundred °C. The supralinearity effect (TL/R increasing with exposure) was studied and found to depend on T^3. Optical repopulation experiments (x irradiation at room temperature, heating to ~200°C to empty all TL traps, cooling to 77°K, and illumination with F-band light) were carried out to study the hole and electron traps of different glow peaks. (D.L.C.)

42753 (NRL-7078) DISLOCATION CHANNELING IN IRRADIATED METALS. Smidt, F. A. Jr. (Naval Research Lab., Washington, D. C.). 24 Feb 1970. 14p.

The present understanding of the phenomenon of dislocation channeling, or the removal of defect aggregates from the slip plane by glide dislocations in irradiated or quenched metals, is reviewed. Channeling is a general feature of any system where penetrable defect aggregates are removed by the glide dislocations. The crystallography of the channels and their correspondence with surface slip traces is shown to be well established. It is shown that several areas of the problem require further research in order to gain an adequate understanding of the phenomenon. In particular the mechanism of initiation of the channels, the dislocation-defect interaction mechanism in which defects are annihilated or assimilated, and the mechanism of work hardening, which stops further deformation in a channel, require further study. In addition, a quantitative correlation between (a) the microscopic parameters of channeling and (b) the macroscopic properties of the work-hardening coefficient and ductility is needed. (auth)

42754 (SC-RR-70-428) RADIATION GENERATED WAVE PROPAGATION IN ELASTIC NONCONDUCTORS. Nunziato, Jace W. (Sandia Labs., Albuquerque, N. Mex.). Jun 1970. 23p. Dep. CFSTI.

The problem of a nonconducting elastic half-space subjected to a transient radiation field characteristic of a laser source is solved using the coupled theory of linearized thermoelasticity and integral transform techniques. A nondimensional WONDY III calculation of the stress histories at the penetration depth and four times the penetration depth is found to be in very good agreement with the exact coupled-theory solution. (auth)

42755 ESR STUDY OF γ-IRRADIATED K_2SeO_4. Aiki, Kunio (Kyushu Univ., Fukuoka). J. Phys. Soc. Jap.; 29: 379-88(Aug 1970).

Structural phase changes in K_2SeO_4 were found at 129.5 and 93°K by introducing free radical SeO_4^- as a probe. The structure in the temperature range between 129.5 and 93°K was expected to be orthorhombic with the crystallographic axes coincident with those of room temperature. The unit cell may contain twelve molecules located at three different sites. A superstructure, a tripled lattice parameter along the a axis, was found by x-ray diffraction and an expected space group is Pnam. It is ferroelectric along the c axis below 93°K. A possible unit cell contains twelve molecules located at six different sites and is monoclinic in the space group $P2_1$, in which the superstructure is maintained. The crystal probably consists of fine twins with the common c axis and they are related with each other by mirror planes. The higher transition is of second order and the lower of first order. Conformations of radicals SeO_4^- and SeO_3^- in the crystal lattice are illustrated. (auth)

42756 ELECTRON SPIN RESONANCE STUDIES OF GAMMA-IRRADIATED ALKALI TITANATE GLASSES. Kim, Y. M.; Bray, P. J. (Brown Univ., Providence). J. Chem. Phys.; 53: 716-23 (15 Jul 1970).

Electron spin resonance studies were made of alkali titanate glasses gamma-irradiated at liquid-nitrogen temperature. The radiation-induced spectrum can be separated into two distinct parts: One is located at a g value greater than that of the free electron, while the other has a lower g value. The latter spectrum consists of two different resonance lines, the broad and sharp spectra. They are identified as arising from Ti^{3+} centers formed in TiO_6 units having one and two nonbridging oxygens, respectively. The high-g-value spectrum is also separated into two distinct resonance lines. Two different hole centers formed in titanium–oxygen units are proposed as being responsible for these resonances. (auth)

42757 ELECTRON SPIN RESONANCE OF AN HYDROGEN CENTER IN PLASTICALLY DEFORMED LiF COLOURED CRYSTALS. Duval, E.; Serughetti, J.; Louat, R. (Faculte des Sciences, Villeurbanne, France). Solid State Commun.; 8: 1155-8 (15 Jul 1970).

On the ESR spectrum of LiF successively γ-irradiated, plastically deformed, and annealed, two lines appear on each side of the F-center spectrum. Their characteristics correspond to those of atomic hydrogen: $g = 2.002 \pm 0.0005$, hyperfine interaction constant = 1420 MHz, $T_1 \simeq 10^{-4} - 10^{-5}$ sec. These lines are inhomogeneously broadened (width ≃ 5G). This center is assumed to be atomic-hydrogen trapped in cavities created by plastic deformation. (auth) (UK)

42758 OPTICAL AND THERMOLUMINESCENCE STUDIES IN X-IRRADIATED ADDITIVELY COLOURED KCl CRYSTALS. Jain, S. C.; Mehendru, P. C. (National Physical Lab., New Delhi). J. Phys., C (London); 3: 1491-7(Jul 1970).

The rate of growth of F centres and thermoluminescence studies in highly pure additively coloured and then x-irradiated KCl crystals shows that the first stage of coloration is considerably suppressed and the second stage is enhanced in these crystals. The value of the parameter a defining the linear rate of growth of F centres in the second stage is also high in additively coloured crystals. The thermoluminescence peak positions and the ratio of the excess concentrations of F centres generated during x irradiation and the corresponding thermoluminescence areas for the additively coloured and then x-irradiated KCl crystals are the same as observed earlier by Jain and Mehendru (1965) for highly pure KCl crystals that were not additively coloured prior to x-irradiation. (auth) (UK)

42759 ROLE OF K-SHELL IONIZATION IN THE FORMATION OF F CENTERS IN ALKALI HALIDES AT 78°. I. KBr. Cruz-Vidal, Baltasar A.; Gomberg, Henry J. (Univ. of Puerto Rico, Mayaguez. Puerto Rico Nuclear Center, Mayaguez). J. Phys. Chem. Solids; 31: 1273-80(Jun 1970).

Within the uncertainty of the experiment, the rate of F-center formation per unit energy retained in Harshaw KBr irradiated at 78°K at equal energy flux is the same (0.78 ± 0.02 F center/keV) whether the incident-photon energy is 13.4 keV or 14.1 keV. (The K edge of bromine is at 13.5 keV.) Since a large background of multiply ionized atoms is expected whether the incident-photon energy is 13.4 keV or 14.1 keV, the above result is not sufficient evidence to conclude that a Varley mechanism of F center formation is not operative. Each of the monochromatic beams was the x-ray fluorescent output either of powdered RbCl filtered with a thin layer of NaBr or of powdered $Sr(NO_3)_2$ filtered with RbCl. The half-width of each monochromatic beam was 330 eV. An air ionization chamber used to measure the flux was calibrated with a calorimeter. (auth) (UK)

42760 ROLE OF K-SHELL IONIZATION IN THE FORMATION OF F CENTERS IN ALKALI HALIDES AT 78°K. II. RbBr. Cruz-Vidal, Baltasar A.; Diaz-Hernandez, Fernando; Gomberg, Henry J. (Univ. of Puerto Rico, Mayaguez. Puerto Rico Nuclear Center, Mayaguez). J. Phys. Chem. Solids; 31: 1281-5 (Jun 1970).

Within the uncertainty of the experiment, the rate of F center formation per unit energy retained freshly cleaved RbBr (grown from purified material under a bromine–argon atmosphere) irradiated at 78°K at approximately equal energy flux is the same (0.342 ± 0.005 keV^{-1}) whether the incident-photon energy is 13.4, 14.1, 14.9, or 15.7 keV. (The K edge of bromine is at 13.5 keV and the K edge of rubidium is at 15.2 keV.) Each of the monochromatic beams was the x-ray fluorescent output of RbCl filtered with a thin layer of NaBr, of $Sr(NO_3)_2$ filtered with RbCl, of $Y_2(CO_3)_3 \cdot 3H_2O$ filtered with $Sr(NO_3)_2$, or of Zr filtered with $Sr(NO_3)_2$. The half-width of each monochromatic beam was 330 eV. (auth) (UK)

42761 ROLE OF K-SHELL IONIZATION IN THE FORMATION OF F CENTERS IN ALKALI HALIDES AT 78°K. III. KCl. Cruz-Vidal, Baltasar A.; Nino-Rojas, Laureano; Gomberg, Henry J. (Univ. of Puerto Rico, Mayaguez. Puerto Rico Nuclear Center, Mayaguez). J. Phys. Chem. Solids; 31: 1287-90(Jun 1970).

Within the uncertainty of the experiment, the rate of F-center formation per unit energy retained in Harshaw KCl irradiated at 78°K at equal energy flux is the same whether the incident-photon energy is below (2.62 and 2.81 keV), between (3.31 and 3.59 keV), or above (3.69 and 4.01 keV) the chlorine (2.82 keV) and potassium (3.61 keV) K edges. Since an initial photoionization in the L_{II} or L_{III} subshell of a chlorine ion is expected to result in an average loss of 2.3 electrons, while an initial photoionization in the K shell is expected to result in an average loss of 4.2 electrons, the result indicates that the multiple ionization of the halogen (Varley mechanism) is not the dominant mechanism of Frenkel defect formation in KCl at 78°K. Each of the beams used was the x-ray fluorescent output of LiCl, or of $K_2C_2O_4 \cdot H_2O$, or of CaO. (auth) (UK)

42762 EPR IDENTIFICATION OF V_1 CENTERS IN IRRADIATED BeO. Herve, A.; Maffeo, B. (Centre d'Etudes Nucleaires, Grenoble, France). Phys. Lett.; 32A: 247-8(27 Jul 1970).

Electron-irradiated (single-crystal) BeO studied by EPR at liquid helium temperatures shows spectra attributed to holes trapped at cation vacancies, V_1 centers. Room-temperature studies and comparison with similar impurity-associated defects obtained by γ irradiation support the model. (auth)

42763 ANOMALOUS F-COLOURING BEHAVIOUR OF IRRADIATED ALKALI HALIDES. Sanchez, C.; Jaque, F.; Agullo-Lopez, F. (Junta de Energia Nuclear, Madrid). J. Phys. Chem. Solids; 31: 1642-3(Jul 1970).

Detailed investigations on the anomalous colouring of NaCl showed that it appeared whenever the irradiation was resumed after a certain interruption time. The magnitude of this effect depended on the type and intensity of radiation. The anomalous colouring zones, also termed "transient regions of colouring," were not observable when the dose given to the crystal after the interruption was sufficiently high. An anomalous F-curve could be obtained by irradiating the crystal with short partial doses separated by interruptions. Essentially, the same behaviour as in pure NaCl was observed in Ca^{2+}- and Sr^{2+}-doped NaCl. The question of the existence of the transient colouring effects in other alkali halides was investigated. The experiments indicated the existence of transient zones in x- and γ-irradiated KCl and KBr, but no anomalous colouring was detected in LiF under the same conditions. (UK)

42764 PENETRATION OF ELECTRONS IN ALKALI HALIDE SINGLE CRYSTALS AND THE EFFECT OF NONUNIFORM IRRADIATION ON COLOUR CENTRE GROWTH CURVES. Herrmann, F.; Pinard, P. (Institut National des Sciences, Lyon). J. Phys., C (London); 3: 1037-46(May 1970).

Growth curves of F centres in KCl, KBr, KI, and NaCl single crystals up to saturation are measured at room temperature by irradiation with 5 to 45-keV electrons. The optical density at saturation was found to be proportional to E^n, with E the energy of incident electrons and n a parameter equal to between 1.35 and 1.69 according to the material. The F-centre formation efficiency at the beginning of the late stage of coloration was found to be independent of electron energy. The experimental results enabled a hypothesis to be made about the behaviour of the absorption coefficient α, by means of which it is shown that the electron range T obeys the same relationship $T \propto E^n$. For α as a function of time two approximating functions, which follow from the experiment, are given. (auth) (UK)

42765 DIFFUSE X-RAY SCATTERING OF γ-IRRADIATED LiF SINGLE CRYSTALS. Spalt, H. (Technische Hochschule, Darmstadt, Ger.). Z. Angew. Phys.; 29: 269-76(1970). (In German).

X-ray diffuse scattering is determined near Bragg peaks of γ-irradiated LiF single crystals. As predicted by theory, scattered intensity close to the ordinary reflections is affected by cluster formation of defects, whereas far from the reflections it is not. The distribution of diffuse scattered x rays in reciprocal space and its dependence on the concentration of color centers yields information on the agglomeration of defects: from optical absorption experiments it is well known that vacancies are present as isolated defects (F-centers). After 200-hr irradiation, 200 to 300 interstitial atoms form clusters with diameters of about 7 lattice spacings. The strain fields of the clusters are anisotropic. (auth)

42766 LUMINESCENCE, TRAPPING, AND F CENTERS IN LITHIUM FLUORIDE CRYSTALS. Miller, Lewis D. (Stanford Univ., Calif. Naval Radiological Defense Lab., San Francisco); Bube, Richard H. J. Appl. Phys.; 41: 3687-97(Aug 1970).

Single crystals of lithium fluoride from various sources were investigated by optical absorption in the visible and in the vacuum ultraviolet, by irradiation with x rays or with ultraviolet from a microwave discharge source, and by measurement of total luminescence output and of luminescence emission spectra as a function of temperature, optical and thermal bleaching of absorption centers, and thermally stimulated luminescence. In addition to obtaining specific quantitative data on the parameters of the F center, hole traps, and luminescence centers in lithium fluoride, it is concluded that the dominant luminescence and trapping centers are associated with specific impurities in the lithium fluoride, and that the F centers are not involved in the production of visible x-ray induced or thermally stimulated luminescence. (auth)

42767 DEPTH PROFILES OF THE LATTICE DISORDER RESULTING FROM ION BOMBARDMENT OF SILICON SINGLE CRYSTALS. Feldman, L. C.; Rodgers, J. W. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys.; 41: 3776-82 (Aug 1970).

The depth profile of the lattice disorder resulting from the ion bombardment of single crystals is of interest in many applications. It has been shown that the channeling effect is sensitive to such lattice damage and has been used in extracting the total damage caused by short-range ion bombardment. This paper describes an extension of the channeling technique which yields not only the amount of damage but certain parameters of the depth distribution of the damage. This method is applied to the case of 200- to 500-keV light ion bombardment in silicon. The results of the measurements and analysis indicate that: (1) Annealing at room temperature is an important process in determining the extent and characteristics of the damage. (2) The peak of the damage distribution is 10 to 20% shallower than the expected range of the ion. (3) The widths of the damage distribution are significantly broader than the expected width of the ion distribution. (auth)

42768 DEFECT CENTERS IN $GaAs_{1-x}P_x$ ELECTROLUMINESCENT DIODES DUE TO HIGH-ENERGY ELECTRON IRRADIATION. Schade, H.; Nuese, C. J.; Herrick, D. (RCA Labs., Princeton, N. J.). J. Appl. Phys.; 41: 3783-9(Aug 1970).

Defect centers were generated in $GaAs_{1-x}P_x$ electroluminescent diodes by 1-MeV electron irradiation. Junction capacitance and thermally stimulated current measurements on the irradiated diodes indicate two distinct types of centers. The first, an acceptor center in concentrations of $1 - 5 \times 10^{17}$ cm^{-3}, is found to be independent of $GaAs_{1-x}P_x$ alloy composition, and is thought to be primarily responsible for an efficiency degradation previously described for irradiated $GaAs_{1-x}P_x$ diodes. The second is a trapping center which is located 0.20–0.35 eV from either band edge, and whose concentration is shown to increase with alloy composition from 1×10^{15} cm^{-3} at $x = 0$ to 4×10^{16} cm^{-3} at $x = 0.5$. The two types of defects are each found to anneal from $GaAs_{1-x}P_x$ at temperatures less than about 550°C. Furthermore, the annealing characteristics of the irradiated diodes establish a definite correlation between the generation and removal of the defect centers and the degradation and recovery of junction electroluminescent efficiencies. (auth)

42769 EFFECTS OF ELECTRIC FIELDS ON THE APR SPECTRA OF Cr^{2+}:Al_2O_3. Anderson, R. S.; Bates, C. A. (Nottingham Univ., Eng.). J. Phys., C (London); 3: L139-43(Jul 1970).

Preliminary results showing the effects of externally applied electric fields up to 50 kV cm^{-1} on the APR spectra from x-irradiated ruby crystals are reported. A brief discussion of the results obtained is given. (auth) (UK)

42770 STUDY OF IRRADIATED SILICA–ALUMINA. III. CORRELATIONS BETWEEN THE SUPERFICIAL ELECTRON DONOR-ACCEPTOR PROPERTIES AND THE POINT DEFECTS IN SILICA–ALUMINA STUDIED BY ELECTRON SPIN RESONANCE. Vedrine, Jacques (Centre National de la Recherche Scientifique, Villeurbanne, France). J. Chim. Phys.; 67: 437-41(Mar 1970). (In French).

F and V centers could be observed at 77°K by ESR in a silica–alumina powder irradiated by γ radiation. The variations of concentration and thermal stability of these defects were studied by modifying the pretreatment conditions. The formation of these centers is found to be due to the elimination of internal or superficial hydroxyl groups under heat treatments or γ irradiation. Correlations between these defects and strong oxidizing or reducing sites of catalyst were found. The increase in the oxidizing power due to oxygen results from its direct adsorption upon the oxidizing site. (tr-auth) (France)

42771 DETERMINATION OF BOND ENERGY OF SILICA GLASS BY MEANS OF ION SPUTTERING INVESTIGATIONS. Bach, H. (Jenaer Glaswerk Schott and Gen., Mainz). Nucl. Instrum. Methods; 84: 4-12(1970).

Sputtering yields of glasses and monocrystalline nonconductors were determined within ±5% accuracy by means of an argon ion beam at 5 keV. In their unified sputtering theory Brandt and Laubert found a relation for the sputtering yield Y: $Y \approx [(dE/dR)/U]\varphi$, where U is the displacement energy, and φ is a function of the atomic number of ions and target atoms, of ion energy E, and of specific energy loss dE/dR. The sputtering yield Y was measured for various crystalline non-conductors, such as Al_2O_3, Ge, SiO_2, TiO_2, MgO, ZnS, PbS, $CaCO_3$, CaF_2, LiF, and NaCl, and compared with theoretical values of Y according to Brandt and Laubert. The results show that the relation of Brandt and Laubert is also a relatively good approximation for nonconductors. The extent of radiation annealing and displacement energy can be estimated. Radiation annealing of SiO_2 (low quartz) is almost zero at temperatures <200°C. Consequently, the displacement energy of SiO_2 is nearly equal to its bond energy. From Y and dE/dR of thin silica glass layers, the molar bond energy of silica glass layers is estimated to be lower than that of low quartz by no more than 3%. According to measurements of sputtering yields this value also applies to silica glass, Herasil. (auth)

42772 STRUCTURE OF TRAPPED-HOLE CENTERS IN γ-IRRADIATED BORATE GLASSES. Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Phys.; 53: 468-71(1 Jul 1970).

In the model proposed by Griscom, Taylor, Ware, and Bray (J. Chem. Phys. 48: 5158(1968)) for the hole center in γ-irradiated lithium borate, the unpaired electron occupies a π-bonding orbital confined to a bridging O atom and one boron atom. This kind of center is pointed out to be chemically and structurally improbable, and an alternative structure is more likely, in which the unpaired electron is placed in a nonbonding orbital on one or more nonbridging O atoms directly bonded to B. Reasons for preferring this structure are given. A reply by Griscom and Taylor is included, in which they agree with the hole-on-a-nonbridging oxygen model. (D.L.C.)

42773 ANNEALING OF ION BOMBARDMENT DAMAGE IN Ge. Zwangobani, E.; MacDonald, R. J. (Australian National Univ., Canberra). Phys. Lett.; 32A: 308-9(10 Aug 1970).

Sputtered atom ejection patterns were used to detect the temperature-dependent amorphous-to-crystalline transition in Ge(111) crystals after bombardment with 10- and 15-keV Ar^+ ions. An activation energy for defect annealing was calculated from the results. (auth)

42774 REPORTED TWINNING AND DISLOCATIONS IN GADOLINIUM METAL THIN FILMS IDENTIFIED AS OCCURING IN B-TYPE GADOLINIUM SESQUIOXIDE CRYSTALS. Boulesteix, C. (Institut d'Optique, Orsay, France); Pardo, B.; Vallergue, L.; Caro, P. E.; Gasgnier, M.; LaBlanchetais, C. H. Phys. Lett.; 32A: 361-2(10 Aug 1970).

Twinning and dislocations reported in gadolinium metal thin films by Srivastava, Kumar and Silcox, are shown to be occurring, in fact, in crystals of B-type gadolinium sesquioxide (monoclinic). (auth)

42775 PHOTOCONDUCTIVITY IN γ-IRRADIATED ANTHRACENE CRYSTALS. Watanabe, Yasutaka; Inuishi, Yoshio. Technol. Rep. Osaka Univ.; 20: 25-31(Mar 1970)

Radiation effects on carrier drift mobilities and lifetimes were studied in anthracene single crystals irradiated with γ rays. Measurement of the hole drift mobility at various temperatures and radiation doses show that for doses above 6.6×10^4 r, holes interact with a new defect center introduced by γ irradiation that is located about 0.4 eV above the valence band and have a concentration of $\sim 10^{15} cm^{-3}$, and the effect of temporary trapping at shallow traps in the host crystal is not important. The hole lifetime, which is 25 μ sec before irradiation, decreases to a value of 6.1 μ sec after a dose of 6.6×10^4 r. This probably is due to a large cross section of $\sim 10^{-15} cm^2$ for holes of the deep center that have an effect on hole transport for high radiation doses. The lifetime for electrons also diminishes when the total dose increases. A similar tendency is observed for the mobility, as its temperature dependence remains unchanged. (auth)

42776 FORMATION OF PARTICLE TRACKS. Katz, R.; Kobetich, E. J. (Univ. of Nebraska, Lincoln). Radiat. Eff.; 3: 169-74(Jun 1970).

The formation of particle tracks, and such phenomena as the detection of charged particles and the damage produced by charged particles, is intimately related to the spatial distribution of ionization energy deposited by δ rays. Changes in the spectrum of δ rays with the velocity of the primary particle imply that linear measures of the interaction of the primary particle with the medium, such as specific energy loss or primary ionization, are unsatisfactory measures of effects produced in the medium, for they contain no knowledge of the spatial deposition of the lost energy. (auth)

42777 STUDY OF RADIATION DAMAGE IN SILICON WITH THE SCANNING ELECTRON MICROSCOPE. Davidson, S. M. (Oxford Univ.). Nature (London); 227: 487-8(1 Aug 1970).

The scanning electron-microscope electron-channelling pattern technique (Coates, Phil. Mag. 16: 1179(1967); Booker et al. loc. cit 16: 1185 (1967)) was used in conjunction with anodic stripping to study the variation of crystalline perfection in Si due to high-energy ion radiation damage with ion dose, depth below the surface, and annealing treatment. Silicon slices were irradiated with 80-keV Ne^+ ions in the Harwell heavy ion accelerator to doses of 10^{14} to 10^{16} ions/cm^2. A scanned ion beam was used and some specimens were subsequently annealed at up to 900°C. The progressive change in electron channelling pattern contrast with dose was determined. A dose of 4×10^{15} ions/cm^2 gave an easily visible milky appearance characteristic of a surface amorphous layer, whereas lower doses gave slight surface coloration. The reduction in contrast for intermediate doses could have been due either to small disordered zones in an otherwise perfect lattice or to a complete amorphous layer just beneath surface. In order to determine which of these possibilities was correct, a conventional anodic stripping procedure was employed and a channelling pattern taken from each anodised area. The results for 7×10^{14} ions/cm^2 indicated a buried amorphous layer, probably extending closer to the surface than 500 Å and down to about 1500 Å. A thicker buried amorphous layer was observed at 1.3×10^{15} ions/cm^2 and this reached the surface at a dose of 3×10^{15} ions/cm^2. Details are given for assessing the amount of contrast in a pattern and the variation of contrast with depth was determined for four ion doses. When a Si specimen with an amorphous surface layer was annealed at 600° to 950°C, a very poor channelling pattern was obtained, and when a similar specimen was chemically thinned from the unirradiated side and observed in the transmission electron microscope, a highly irregular structure was seen, which could be interpreted as a combination of microtwins and rotation moiré fringes, and the degree of misorientation present in the structure was about 1°. (UK)

42778 LOW-TEMPERATURE SURFACE MIGRATION OF TUNGSTEN, ACTIVATED BY ION BOMBARDMENT. Dranova, Zh. I.; Mikhailovskii, I. M. (Physical-Technical Inst., Kharkov). Sov. Phys.-Solid State (Engl. Transl.); 12: 104-8(Jul 1970). Translated from Fiz. Tverd. Tela; 12: 132-7(Jan 1970).

The structure and topography of acicular tungsten microcrystals were studied using the techniques of field-emission and field-ion microscopy. The microcrystals were bombarded with helium ions having energies from 500 to 2500 eV. Ion bombardment of an emitter in a 5×10^7 V/cm electric field reduces the average radius of tip curvature and creates a large number of microtuberances 20 to 50 Å in diameter and 4 to 10 Å in height. The deformation of the emitter is a result of surface migration of atoms, caused by the ion bombardment. An anomalously high concentration of point defects and microcavities was observed by carrying out layer-by-layer evaporation in the field. The formation of cavities is assumed to be a consequence of migrational coagulation of submicroscopic pores. (auth)

42779 LATTICE DISORDER IN GERMANIUM BY BORON ION BOMBARDMENT. Sigurd, D.; Fladda, G.; Eriksson, L.; Bjoerkqvist, K. (Research Inst. for Physics, Stockholm). Radiat. Eff.; 3: 145-7(Jun 1970).

The lattice disorder produced in germanium by 56-keV boron-ion bombardment has been measured using the channeling-effect

technique. The dependence on dose ($10^{14} - 10^{16}$ ions/cm^2) and implantation temperature (–90°C to +130°C) has been studied. It is found that at room temperature, each incident boron ion creates ~10 times more disorder in germanium than in silicon. It is remarked that, contrary to the present results, previously established anneal stages generally occur at significantly lower temperatures in germanium than in silicon. (auth)

42780 TRACK-FORMATION MECHANISMS IN MINERALS. Maurette, M. (Washington Univ., St. Louis). Contract Z-80058T. Radiat. Eff.; 3: 149-54(Jun 1970).

The main features of heavy-ion track registration in nonconductor minerals are presented. In particular, experimental results obtained recently by several authors are used to identify those features which are directly related to the radiation damage mechanism producing the tracks, rather than to the decoration process employed to observe them. Following a brief discussion of the various atomic species formed along the trajectory of an ion in a solid, a discussion is given of the adequacy of various radiation-damage theories in explaining the formation of tracks in minerals. It is concluded that the 'ion explosion spike' model proposed by Fleischer, Price and Walker (J. Appl. Phys. 36: 3645(1965)) is still the best approximation for describing the formation of heavy-ion tracks in minerals. (auth)

42781 STUDY BY SMALL-ANGLE X-RAY SCATTERING OF MUSCOVITE MICA IRRADIATED BY ARGON IONS. Lambert, M. (Faculte des Sciences, Orsay, France); Levelut, A. M.; Maurette, M.; Heckman, H. Contracts NASA 9,8165; Z-80058T. Radiat. Eff.; 3: 155-60(Jun 1970). (In French).

The mechanism of track formation in muscovite mica was studied using x-ray small-angle scattering. The samples were irradiated with argon ions of minimum energy 1 MeV/nucleon, the integrated doses ranging from 3×10^{12} to 10^{13} argon ions/cm^2. Experiments show that point defects are formed with a concentration of the order of 1 per cent. In the case of argon ions of 1 MeV/nucleon energy (maximum energy loss rate), additional larger defects, with a size of about 20 Å, are also created. The effect of thermal annealing and chemical etching was also studied to relate the possibility of track development with the presence of such defects. (auth)

42782 DIFFUSION OF ION-AIMPLANTED Kr IN RbCl AND THE EFFECTS OF RADIATION DAMAGE. Pronko, P. P.; Kelly, R. (McMaster Univ., Hamilton, Ont.). Radiat. Eff.; 3: 161-7 (Jun 1970).

The diffusion of Kr in RbCl single crystals was studied following Kr implantation at 15 keV and doses of 3.7×10^{13} to 3.7×10^{15} ions/cm^2. The compound exponential depth distribution was utilized by comparing ordinarily implanted specimens with others having the outermost ~2000 Å removed in n-butanol so as to leave only the deeply channeled portion of the incident beam in an ambient of low damage concentration. Two diffusion mechanisms were found, one at 150–300°C, with an activation enthalpy of 1.21 ± 0.07 eV, and one at 300–450°C, with an activation enthalpy of 2.3 ± 0.2 eV. The first process corresponds reasonably well to Norgett and Lidiard's description of interstitial diffusion in the presence of extrinsic or collisionally produced single-vacancy traps, for which an activation enthalpy of 1.28–1.78 eV was calculated. The second process is not so easily interpreted but possibly corresponds to interstitial diffusion in the presence of small vacancy clusters or small gas clusters, with or without concurrent radiation-damage annealing. A comparison of the pre-exponential factors for the first process as a function of dose allows the single-vacancy concentrations in the bombarded regions to be estimated, and evidence is presented that the concentration saturates at about $2 \times 10^{-2\pm1}$ atomic fraction for doses in excess of 5×10^{15} ions/cm^2. It is shown that the interstitial frequency factor Γ_0 works out to about $1 \times 10^{12\pm1}$ sec^{-1} on the basis of the proposed diffusion mechanism. This is a reasonable value and tends to confirm the model. (auth)

42783 DAMAGE RATE AND RECOVERY MEASUREMENTS ON ZIRCONIUM AFTER ELECTRON IRRADIATION AT LOW TEMPERATURES. Neely, H. H. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. Radiat. Eff.; 3: 189-201(Jun 1970).

Resistivity change as a function of electron irradiation near 8°K and of annealing after irradiation was measured on zirconium. Damage rates were measured as a function of incident electron energy from 0.70 to 1.9 MeV. A value of 24 eV for the displacement threshold energy was determined by extrapolation of the damage rate curve to zero damage production. A fit between the theoretical and experimental values of displacement cross section was achieved with an effective threshold energy of 28 eV, yielding 35×10^{-4} Ω-cm/fractional concentration for the Frenkel resistivity. The damage-rate curve indicates no tailing due to subthreshold displacements. Recovery in Zr is analogous to that of fcc and bcc elements studied, but with six substages in Stage I. Substage I_E (analogous to I_e in other materials) was analyzed by using the serpentine plot, which gives an indication of long-range migration of an interstitial between 120 and 150°K, with an activation energy of 0.26 eV (second-order kinetics is assumed). Stage III is in the temperature range 250 to 310°K. The activation energy of Stage III was analyzed by use of the Meechan–Brinkman and second-order methods; this results in an average energy of 0.57 eV. The order of reaction kinetics was found to be a function of recovery. (auth)

42784 NEUTRON-IRRADIATED MOLYBDENUM: RELATIONSHIP OF MICROSTRUCTURE TO IRRADIATION TEMPERATURE. Brimhall, J. L.; Mastel, B. (Pacific Northwest Lab., Richland, Wash.). Contract AT(45-1)-1830. Radiat. Eff.; 3: 203-15 (Jun 1970).

The microstructural defects produced in molybdenum by neutron irradiation in the temperature range 50 to 800°C were characterized by transmission electron microscopy. At a low irradiation temperature, 50°C, a large number of small dislocation loops, presumably interstitial, form within a complex dislocation network. At intermediate temperatures, 400 to 600°C, small interstitial loops agglomerate into rafts. At high temperatures, 600 to 800°C, the small loops which comprise a raft are sufficiently mobile to form large loops which interact with each other to produce a coarse dislocation network. The migration of small loops through the lattice by a combination of prismatic glide and conservative climb accounts for the observed microstructures. Vacancy loops are the only identifiable vacancy defects at temperatures ≤500. Between 575 to 650°C, both vacancy loops and voids exist. Above 650°C, to at least 800°C, voids are the exclusive vacancy defect. Information on the effect of impurities and grain boundaries on the configuration and distribution of visible defects is presented. (auth)

42785 RADIATION DAMAGE IN TUNGSTEN: ITS INFLUENCE ON THE TRAPPING AND SUBSEQUENT THERMAL DESORPTION OF HELIUM. Farrell, G.; Grant, W. A. (Univ. of Salford, Eng.). Radiat. Eff.; 3: 249-58(Jun 1970).

Desorption spectra of various doses of 160-eV helium ions injected into a damaged polycrystalline tungsten target are described. Conclusions derived from these are applied to the interpretation of spectra obtained for the injection of helium (at different energies and doses) into an undamaged target, and are shown to be consistent with the spectral variations observed. Experiments are described in which a damaged target was partially annealed prior to the injection of 160-eV helium, with the result that the desorption spectra were modified in such a way as to reveal new information about certain trapping sites and release processes in tungsten. (auth)

42786 MERCURY ION IMPLANTATION IN SILICON: LATTICE DISORDER CREATED IN Hg ATOM LATTICE LOCATION. Della Mea, G. (Univ., Padua); Drigo, A. V.; Mazzoldi, P.; Nardelli, G.; Zannoni, R. Radiat. Eff.; 3: 259-62(Jun 1970).

The lattice disorder produced by 42- and 75-keV Hg ions implanted in silicon at room temperature and the lattice location of the Hg atoms were studied by means of the channeling technique with a 2.0-MeV $^4He^+$ beam. The damage produced was found to increase linearly with ion dose until a saturation value, related to the ion range, is reached. The number of Si atoms displaced for Hg ion implanted was evaluated and compared with the theoretical expectation. The substitutional Hg fraction is related to the disorder produced: the replacement mechanism is discussed. (auth)

42787 DOSE DEPENDENCE OF STAGE III RECOVERY IN NEUTRON-IRRADIATED MOLYBDENUM. Goedeme, G.; Pande, B. M.; Stals, L.; Nihoul, J. (SCK/CEN, Mol, Belgium). Radiat. Eff.; 3: 275-7(Jun 1970).

An analysis of more than 20 isochronal annealing data of stage III recovery in neutron-irradiated molybdenum definitely shows a peak temperature shift of 80°K over a concentration range of 2.5 decade. (auth)

42788 INTERSTITIAL STABILIZATION AND COLOR-CENTER PRODUCTION IN KBr. Giuliani, G. (Univ., Pavia, Italy). Phys. Rev., B; 2: 464-71(15 Jul 1970).

An investigation was conducted of the color-center production in KBr containing alkali impurities (Li, Na, and Rb). It turns out that alkali impurities enhance the color-center production at 80°K only if their size is smaller than that of the substituted ion. Typically, in sodium- or lithium-doped samples (1% in the melt) the average α- and F-center production efficiencies are increased by more than an order of magnitude and by a factor of 2–3, respectively. In KBr: Na, the enhancement of the α- and F-center production is related to the growth of the well-known V_1 and I

(interstitial negative ion) bands (not observed at 80°K in sufficiently pure samples). Similarly, in KBr: Li, the increase of the α- and F-center production is related to the growth of an I-type band (peaking at 223 mμ) and of two V_1-type bands (peaking at 390 and 438 mμ). The analysis of the growth- and thermal-decay properties of the I- and V_1-type bands, with respect to those of the α and F bands, leads to the conclusion that the enhancement of the α- and F-center production is due to the trapping and the stabilization of interstitial halogens by sodium or lithium impurities. Finally, the fact that lithium-trapped interstitials are more stable than those trapped by sodium, along with the fact that rubidium impurities (1% in the melt) do not affect the color-center production, supports an interstitial-stabilization mechanism based on the reduction of the repulsive forces acting on the interstitials when they are trapped near suitable impurities. (auth)

42789 FORMATION OF F_2^+ CENTERS IN KI. Kouvalis, Alexander (Zenith Radio Corp., Chicago). Phys. Rev., B; 2: 509-12(15 Jul 1970).

When undoped KI is x-rayed at 130°K and then irradiated with F light at 240 or 270°K, the M and R centers are formed. Subsequent irradiation at 78°K with M_L light results in the formation of an optical-absorption band at 1650 nm at the expense of the M band. Studies suggest that it is associated with F_2^+ centers (formerly called M^+), which are formed at 78°K by (i) $V + F_2 + (M_L \text{ light}) \rightarrow V^- + F_2^+$ (where M_L light represents light absorbed by the M_L bands) and destroyed by x rays at 78°K, by (ii) $V^- + F_2^+ + (\text{x rays}) \rightarrow V + F_2$ [where V^- is an electron center containing a halogen (V) center core]. F_2^+ centers may also be destroyed at 78°K by F light, by (iii) $V^- + F_2^+ + F + h\nu_F \rightarrow V^- + F_2 + \alpha$. Studies show that the F_2^+ center is not formed optically as a result of V_K excitation, but only by direct ionization. The formation of F_2^+ centers by M_L light irradiation in x-rayed colored crystals seems to depend on the existence of V centers which act as special electron traps. (auth)

42790 CLASSICAL DIRECTIONAL EFFECTS FOR ENERGETIC ELECTRONS IN CRYSTALS. Lindhard, J. (Univ. of Aarhus, Denmark). pp 1-2 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Particular classical aspects of directional effects for electrons in crystals are discussed. The basis is a description of transverse motion by a Hamiltonian involving averaged potentials, transverse momenta, and the relativistic mass of incoming particles, which for electrons is frequently sufficiently accurate to assume its validity everywhere in the crystal, corresponding to the continuum description. The distinctions between classical and wave treatments are contained mainly in parameters such as barrier penetration, number of quantum states, and incoherence versus interference. For electrons the relativistic mass can easily be varied, permitting closer analysis. The bound states for atomic strings show typical classical behavior, and temporary capture in a string results in lack of coherence with free electron states. The pattern of electrons emitted from a string atom can be estimated classically. The reverse process of an external electron hitting an atomic nucleus can also be described. In a more accurate treatment a closer scrutiny of angular momentum and multiple scattering for bound string states must also be included. It is concluded that although positive particles are in general superior to electrons as investigational tools, classical patterns in electron behavior are of considerable interest. (5 references) (UK)

42791 WAVE TREATMENT OF DIFFRACTION AND CHANNELLING OF FAST ELECTRONS IN CRYSTALS. Whelan, M. J. (Oxford Univ.). pp 3-32 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

The wave theory of propagation of fast electrons in crystals is reviewed. The theory is the well known dynamical theory of electron diffraction. When absorption is included, the theory leads to anomalous transmission, or channelling, of crystal Block waves. Examples are given of the application of the theory to the interpretation of electron-diffraction patterns, electron microscope image contrast effects in crystals, and to channelling effects observed on scanning electron microscope images. (36 references) (auth) (UK)

42792 INTERPRETATION OF ELECTRON PLANAR CHANNELLING DATA. Howie, A.; Spring, M. S.; Tomlinson, P. N. (Cavendish Lab., Cambridge, Eng.). pp 34-48 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

The wave and particle theories of electron channelling are outlined and compared and applied to the analysis of the angular spectra of electrons emitted from crystals and to related channelling effects. The classical theory works well for relativistic electrons, where it gives results whose mean features agree with many-beam wave calculations. (18 references) (auth) (UK)

42793 WEAVING AND BLOCKING OF ENERGETIC ELECTRONS. Nip, Hans C. H.; Kelly, J. C. (Univ. of New South Wales, Sydney). pp 50-63 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

The motion of energetic electrons through a single metal crystal was simulated on an IBM 360 computer using a classical model of correlated multiple scattering. The program is explained and its assumptions are considered. The numerical results of the simulation are presented and compared with the available experimental data. (12 references) (auth) (UK)

42794 THE DIRECT OBSERVATION OF HEAVY-ION COLLISION CASCADES BY FIELD ION MICROSCOPY. Hudson, J. A. (Atomic Energy Research Establishment, Harwell, Eng.); Ralph, B. pp 85-96 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Prepared field-ion specimens of iridium were bombarded in a field-ion microscope by 20- to 100-keV positive ions from a heavy-ion accelerator directly linked to the microscope, at room temperature and at 78°K, with and without an applied imaging electric field. Radiation damage was observed at the surface and in the bulk of the specimens, the latter via controlled field evaporation. The size distribution of damage-formed vacancy clusters was determined from specimens bombarded with various ions imparting a range of knock-on energies to the iridium atoms. The mean diameter of the clusters was constant at about 25 Å for mean knock-on energies above about 16 keV, whereas below this energy many smaller aggregates were formed. It is suggested that this "cut off" represents the maximum energy for the formation of a single depleted zone in a collision cascade. Several shallow craters were observed on the surfaces of irradiated specimens, and the maximum linear dimensions of these craters was 3 or 4 times the maximum size of vacancy aggregates encountered in the field evaporation sequences. Such craters may represent the skeletons of whole collision cascades intersecting the surface, and the dimensions would be those of cascades. (14 references) (auth) (UK)

42795 SPATIAL DISTRIBUTION OF VACANCY CLUSTERS IN ION-BOMBARDED METALS. Norris, D. I. R. (Berkeley Nuclear Labs., Eng.). pp 97-110 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Stereo electron microscopy was used to obtain depth distributions of point defect clusters in gold, copper, and nickel bombarded with 80- to 150-keV heavy ions. At the energies and doses employed the clusters were of vacancies resulting from displacement cascades and they were found at depths comparable to the ranges of the bombarding particles. The observed distributions in gold and copper agreed well with damage distributions calculated from the theory of Sigmund and Sanders and the effects of changing the bombarding-ion energy or its species were as predicted. In nickel the agreement was poor and the ratio of median cluster depth to theoretical mean damage position was 0.5. Cluster size distributions did not vary significantly with depth into the specimen. There was no significant denuded layer caused by loss of clusters from near the surface. (11 references) (auth) (UK)

42796 LATTICE DISORDER PRODUCED IN SILICON BY BORON-ION IMPLANTATION. Eisen, F. H. (North American Rockwell Corp., Thousand Oaks, Calif.); Welch, B.; Westmoreland, J. E.; Mayer, J. W. pp 111-27 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

The depth distribution of the amount of disorder produced in

random and channeled (⟨110⟩ axis) boron implants in silicon was studied from the orientation dependence (channeling) of the yield of backscattered helium ions or protons. The effects of dechanneling the analyzing beam were subtracted using a computer program that calculated the multiple scattering due to the disorder. The implants were performed at room temperature or at −150°C and the implant energies were varied from 60 to 300 keV. The amount of disorder produced by a given dose was significantly greater at −150°C than at room temperature. Measured values of the disorder peak depths varied from 1200 Å for a 60-keV implant to 6900 Å for a 300-keV implant, while the depths for the channeled implants ranged from 3500 Å for a 60-keV implant to 7700 Å for a 200-keV implant. The total amount of disorder observed in the samples with channeled implants relative to that in samples with random implants depended on the implant temperature; the ratio was about one half for room temperature implants of the same dose, and was appreciably lower for −150°C implants warmed to room temperature in order to make the measurements. (18 references) (auth) (UK)

42797 LOW-ENERGY ION BOMBARDMENT OF SOLIDS. Venables, J. A. (Univ. of Sussex, Brighton, Eng.). pp 132-61 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

A selection was made of phenomena associated with ion bombardment of solids at energies ≲1 keV. The selection is biassed, favouring firstly phenomena that can be interpreted relatively easily and, secondly, information obtained by microscopic techniques. The paper is divided into two major sections, dealing with collision and diffusion processes, respectively. The first section deals with focussed collision sequences, the fate of the incoming ion and, very briefly, low-energy sputtering. The second section, on diffusion processes, deals with the form the damage takes in different materials and the release of trapped gases. It also contains a description of the techniques of stereo-electron microscopy, and describes experimental results on interstitial atom diffusion and interstitial cluster formation, obtained by this technique. (63 references) (auth) (UK)

42798 AMORPHISATION OF SILICON CRYSTALS DURING ATOMIC PARTICLE BOMBARDMENT. Gusev, V. M.; Martynenko, Yu. V.; Starinin, C. V. (Inst. of Atomic Energy, Moscow). pp 162-71 of Atomi c Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Minimum doses were determined at which amorphisation of silicon surface layers during different ion bombardments was observed. The experimental results are compared with the theoretical dependence of the amorphisation dose on the atomic number of an ion. (11 references) (auth) (UK)

42799 ION-IMPACT CRYSTALLIZATION OF ZrO_2 AND ITS IMPLICATIONS TO OTHER MATERIALS. STUDIES ON BOMBARDMENT-INDUCED DISORDER. III. Kelly, Roger; Naguib, H. M. (McMaster Univ., Hamilton, Ont.). pp 172-91 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

The impact of heavy ions on solids is known to lead in some cases to amorphization, whereas in other cases the bombarded solid shows little or no change in its crystallinity. Evidence is presented for a third type of structural evolution following ion impact, such that bombardment of amorphous ZrO_2 leads at doses greater than 9×10^{15} ions/cm^2 to complete crystallization. These various responses to ion impact can be only partly accounted for in terms of the anisotropy model of Berman et al., while a displacement-spike model also has inconsistencies. It is shown, however, that a thermal-spike model is more successful. According to this model the criterion for the preservation of disorder (amorphousness) following ion impact is that $D_c t/\lambda$ be much less than λ, where D_c is the diffusion coefficient for crystallization, t is the effective duration of a thermal spike measured for temperatures below the melting point ($\approx 7 \times 10^{-12}$ sec), and λ is the mean atomic spacing. This in turn implies a further relation, namely, that the ratio T_c/T_m (crystallization temperature)/(melting temperature) be greater than 0.23 ± 0.07. Significantly, nine substances that amorphize readily have $T_c/T_m > 0.35$, while seven substances that are stable, including ZrO_2, which shows the sequence amorphous → crystalline, have $T_c/T_m < 0.29$. Possible refinements to the thermal-spike model would include taking excess vacancies into account and allowing for surface free-energy effects. (39 references) (auth) (UK)

42800 THE INFLUENCE OF CHANNELLING ON THE DAMAGE PRODUCTION IN HEAVY-PARTICLE IRRADIATION OF SINGLE CRYSTALS OF GOLD. Merkle, K. L. (Argonne National Lab., Ill.). pp 192-204 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

A single crystal of gold of (001) orientation and 4860 Å in thickness was irradiated at 4.2°K with 120-keV protons and, in a different run, with 120-keV Xe^+ ions. Electrical resistance measurements were used to study the damage rate as a function of the dose and the direction of the ion beam. To distinguish between orientation and saturation effects the damage rate was measured periodically at a fixed orientation. The saturation effects were negligible in the proton irradiation; in the Xe^+ irradiation, however, a strong decrease of damage rate with dose was found. On rotation through the [001] axial channel the relative damage rate did increase towards the channel direction in the Xe^+ bombardment. Irradiation with protons along the [001] channel, however, gave a smaller damage rate compared to irradiation in a random direction. The angular half widths for the proton as well as the Xe^+ case agreed well with the critical angles calculated according to Lindhard's theory. The different sign of the effects was due to the differences in the random range of the ions. The mean projected random range of the protons was comparable to the film thickness, while the amorphous range of the Xe^+ was more than an order of magnitude smaller. The bulk of the crystal could therefore be damaged by the Xe^+ ions only if they could penetrate along a channelling direction. In this case the damage production was mainly controlled by the dechannelling behavior of the ions. The observed damage rates indicated that a large fraction of the ionic energy goes into defect production in the Xe^+ case, while only a small fraction of the proton energy is used up in nuclear displacements. (16 references) (auth) (UK)

42801 ORIENTATION DEPENDENCE OF DEFECT CLUSTER FORMATION IN COPPER DURING ELECTRON IRRADIATION. Makin, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 205-16 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

The accelerating voltages available in high-voltage electron microscopes are sufficient to produce atomic displacements in light and medium atomic weight materials and such instruments have several striking advantages over conventional accelerators for detailed electron radiation damage studies. Interstitial defect clusters were shown to form in copper irradiated at 300°K, the density of clusters as a function of time agreeing well with the number predicted by a homogeneous nucleation theory. A layer denuded of clusters was observed around all surfaces and grain boundaries, the width of this layer also agreeing well with the theory. The displacement energy E_d in particular crystal directions can be quite accurately measured by observing the threshold electron energy as a function of foil thickness, and preliminary measurements indicated that E_d in copper in the ⟨100⟩, ⟨110⟩, and ⟨111⟩ directions is about 21.6, 19.2, and 23.6 eV, respectively. The effect of electron channelling on the damage rate was clearly demonstrated, the damage rate being much less in the so-called "anomalous transmission" regions than in the heavily absorbing region close to the low index planes. The results can be qualitatively explained by the two-beam dynamical theory of diffraction, the low-damage region occurring when the first Bloch wave is dominant, and vice versa. (11 references) (auth) (UK)

42802 USE OF ANISOTROPIC DAMAGE RATE DATA IN DETERMINING ATOMIC DISPLACEMENT ENERGIES. Hemment, P. L. F.; Stevens, P. R. C. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 217-31 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Studies were made, using low-energy electrons in the range 100 to 400 keV, of carrier removal rates in silicon as a function of sample orientation and electron beam energy. The measurements were made at both liquid freon (245°K) and near liquid nitrogen (≈80°K) temperature. Study of the temperature dependence of carrier concentration after irradiation enabled the identification of some defect energy levels produced by 400-keV irradiation and calculation of their introduction rates. Consideration of the factors influencing electron damage rates (including electron beam scattering and energy loss) led to the development of a computer programme to predict damage rates as a function of electron beam

energy, specimen thickness, and crystal orientation with respect to the beam. Comparison of the calculated and experimental results enabled suggestions to be made about the displacement energy as a function of direction in the crystal and determination of an effective threshold energy at 22 eV. The form of the computed displacement energy profile could be justified in a simple manner from crystallographic considerations. Some isotropic damage was also observed in experiments at low electron energies, which were "sub-threshold" in the sense that the maximum recoil energy was below the effective threshold of 22 eV. Evidence was obtained from Hall mobility measurements that this was a fundamentally different form of damage from that produced at higher energies (400 keV). Experiments are being undertaken in an attempt to identify the defects produced by low-energy irradiation, to compare with the identification of the 400-keV defects. The computational process could easily be extended to other materials, and in particular the method was applied to bcc α-iron, for which Erginsoy has produced a displacement energy profile based on a theoretical model of the lattice. It is hoped in this way to obtain a closer link between experiment and theory for this material. (13 references) (auth) (UK)

42803 DAMAGE RATE COMPUTATIONS FOR DIAMOND STRUCTURES UNDER ELECTRON IRRADIATION. Fisher, S. B.; Banbury, P. C. (Univ. of Reading, Eng.). pp 232-45 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Damage rates were computed for comparison with published resistivity and spin resonance measurements in n- and p-type silicon under electron irradiation, for various beam energies and orientations. The model employed the McKinley–Feshbach scattering relation, and assumed displacement to occur for recoil energies greater than E_D, where E_D comprises a constant (bonding) energy E_B and the sum of central repulsive potentials V(r) based on fixed nearest neighbours evaluated at closest approach for a particular recoil direction. Secondary events were introduced by hard-sphere calculations based on a hard-sphere radius derived from the same repulsive potential. The fitting of experimental results led to interactions of the form $E_B \cong 21$ eV, $V \cong 5 \times 10^4 \exp(-r/0.2)$, over the range of r from 1.0 to 2.3 Å. (9 references) (auth) (UK)

42804 LOW-ENERGY ELECTRON AND ULTRAVIOLET SPUTTERING OF KI. Townsend, P. D.; Elliott, D. J. (Univ. of Sussex, Brighton, Eng.). pp 328-38 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Results are presented on the sputtering of alkali halides by low-energy electron and photon bombardment. Of the possible models that could account for such an efficient transfer of energy to lattice atoms, that of Pooley and Hersh seems most suitable. It successfully predicts that sputtering can be produced by light of energy less than the band gap. For example, KI is sputtered with 5-eV photons and NaCl shows measurable ejection even with 10-eV electrons. The efficiency of the process is strongly temperature-sensitive, and experiments are described that attempt to separate the different temperature dependence and ejection pattern expected for each type of atom. The sputtering yield also varies with the crystal face being bombarded, and this may be interpreted as an example of electron channelling into the crystal. (7 references) (auth) (UK)

42805 SOME ASPECTS OF THE THEORY OF ION INTERACTIONS WITH CRYSTAL CHANNELLING. Martynenko, Yu. V. (Inst. of Atomic Energy, Moscow). pp 400-16 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

A survey of general theoretical and some experimental work on channelling of ions in crystals is given. The conditions for entrance of particles into a channel, peculiarities of the particle motion in a channel, and dechannelling factors are considered. Main attention is devoted to axial channelling, but planar channelling is also considered. The influence of such factors as disaligning of the ion beam, thermal vibration, and radiation damage on the channelling range and on the range distribution of the implanted ions is discussed. The survey does not pretend to be a comprehensive collection of all the data on channelling, but all general ideas are discussed. (43 references) (auth) (UK)

42806 CHANNEL STOPPING POWER AND ESCAPE IN LiF. Edge, R. D.; Dixon, R. L. (Univ. of South Carolina, Columbia). pp 435-54 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Three techniques were employed to study the escape of protons from channels in LiF and CaF_2. The first method utilized the narrow resonance at 340 keV in the $^{19}F(p,\alpha)^{16}O$ reaction. Protons introduced at, say, 500 keV, slow down in the crystal to 340 keV, at which point the resonance reaction occurs, releasing alpha particles. A comparison of the alpha-particle spectra in nearby channeled and unchanneled directions can be used to determine where the protons escape from the channel and their energy loss in the channel. The second method employed the nonresonant reaction $^6Li(p,\alpha)^3He$, and the third method Rutherford scattering. The stopping power for protons escaping the ⟨100⟩ channel in LiF was 87 percent of the random stopping power, and the half-thickness for escape from the channel was 0.115 mg/cm^2. For CaF_2 the corresponding quantities were 95 percent and 0.618 mg/cm^2. The large value for the stopping power in the channel can be explained in terms of the variation of rate of energy loss with the amplitude of the anharmonic oscillations of particles in the channel. (15 references) (auth) (UK)

42807 COMPUTER SIMULATION APPLIED TO CHANNELLING. Morgan, D. V. (Atomic Energy Research Establishment, Harwell, Eng.); Van Vliet, Dirck. pp 476-500 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

The techniques of simulating ion trajectories on the computer were applied to several different problems associated with channelling. The conditions for the validity of the continuum approximation were studied in a two-dimensional lattice, and the critical transverse angle, ψ_{crit}, and critical approach distance, ρ_{crit}, were evaluated as a function of energy, interatomic spacing, and temperature. A relatively simple analytic expression for the critical approach distance for a rigid row, ρ_{min}, is proposed. The further dependence of ρ_{crit} on the rms thermal vibrational amplitude, x_{rms}, is given by $\rho_{crit} \approx \rho_{min} + c_2 x_{rms}$ in 2 dimensions and $\rho^2_{crit} \approx \rho^2_{min} + c_3 x^2_{rms}$ in 3 dimensions. In both cases the constants c_2 and c_3 lie between 2.0 and 3.5. The probability of dechannelling near lattice defects (extended defects, stacking faults, dislocations, and point defects) was also assessed. In general, dechannelling arises from either a direct collision with a single displaced atom, or via an interaction with a distorted row. The relative importance of both effects is discussed, and analytic approximations for the computer results are given. (10 references) (auth) (UK)

42808 ELECTRON EXCITATION IN SEMICONDUCTORS BY ION AND ELECTRON BOMBARDMENT. Abroyan, I. A.; Petrov, N. N. pp 553-71 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

A review is given of experimental work on excitation of electrons in semiconductors bombarded with ions and electrons in the energy range 10 eV to 10 keV. Data obtained by various methods (transverse radiation conductivity, separation of excited electrons and holes within p–n junction, luminescence measurements) are considered. Studies are reported on the dependence of excited electrons on energy and nature of projectile and on orientation of beam direction with regard to crystal axes. It is shown that for obtaining quantitative results it is necessary to take into consideration the surface recombination of electron–hole pairs and the kinetic energy of reflected particles. The energy spectrum of excited electrons is discussed. A comparison of experimental data with existing theories is made. (51 references) (auth) (UK)

42809 IMPLANTATION PROFILES OF ENERGETIC HEAVY IONS IN GaAs, GaP, AND Ge. Whitton, J. L.; Carter, G. (Univ. of Salford, Eng.). pp 615-32 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

The effects of incident ion dose, ion type, ion energy, target orientation, and target temperature on the implantation profiles of various ions in GaAs, GaP, and Ge, were studied by the application of vibratory polishing sectioning techniques. Gross radiation damage occurred at the same level in the three targets, as detected visually and by range shortening. Rutherford scattering measurements of Kr-implanted GaAs gave comparable data. This damage could be annealed at 100°C during implanta-

tion, but a temperature of 300°C was required for post-annealing. The oscillating dependence of electronic stopping on the atomic number of the incident ion was reflected in the easily measured maximum ranges of S but not of Zn or Na. Energy dependence of the maximum ranges of S is $E^{0.43}$, which is close to the $E^{0.5}$ expected for electronic stopping. (22 references) (auth) (UK)

42810 RANGE DISTRIBUTION OF RADIOACTIVE IONS IMPLANTED INTO SILICON CRYSTALS. Dearnaley, G.; Wilkins, M. A.; Goode, P. D.; Freeman, J. H.; Gard, G. A. (Atomic Energy Research Establishment, Harwell, Eng.). pp 633-56 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Several types of radioactive ions in the energy range 10 to 120 keV were implanted into Si crystals under varied conditions, and the range distributions determined by the method of anodic stripping. ^{32}P channelled range distributions exhibited a pronounced exponential tail at room temperature, but post-irradiation with ^{20}Ne at 77°K removed most of the effect, which is therefore attributed to the diffusion of interstitial phosphorus. Range distributions of ^{32}P were also measured in Si rendered amorphous by ^{20}Ne bombardment, and the results agreed relatively well with the theoretical predictions of Lindhard, Scharff and Schiøtt. The behaviour of channelled concentration profiles was shown to be dependent upon the quality of Si crystals used. The range distributions of ^{32}P, ^{24}Na, ^{35}S, ^{64}Cu, and ^{85}Kr were compared under channelling conditions, and it is shown that the maximum range is strongly influenced by the ionic size. That the very deep penetrations observed for ^{24}Na and ^{64}Cu ions are due to the channelling process rather than anomalous diffusion was demonstrated by a transmission experiment in which these ions were observed to penetrate thin crystals of Si. The relationship between channelling and interstitial diffusion mechanisms in Si is briefly discussed. (32 references) (auth) (UK)

42811 COMPUTER STUDIES OF B^+ ION PENETRATION INTO Si SINGLE CRYSTAL. Eliteckov, V. A.; Karpuzov, D. S.; Martynenko, Yu. V.; Yurasova, V. E. (Inst. of Atomic Energy, Moscow). pp 657-62 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

Some results of computer simulation of 200-keV B^+ ion penetration into a Si single crystal are given. The simultaneous interaction of an ion with several atoms of the microcrystallite was considered. The Firsov potential at small separations and the Born–Mayer potential for large separations were used. The dependence of an inelastic friction force on the ion position in the crystal was taken into account. The approximate ion penetration profile in perfect single crystals was calculated. (3 references) (auth) (UK)

Physical Properties

Refer also to abstracts 41284, 41285, 42110, 42131, 42264, 42506, and 42608.

42812 (CEA-CONF-1515) NEUTRON PHYSICS FOR MAGNETIC STRUCTURES. Bertaut, E. F. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1969. 26p. (In French). Dep. CFSTI (U. S. Sales Only).

Topics covered are: structure factors; the Born approximation; nuclear and magnetic amplitudes; polarized neutrons; polarization analysis. (France)

42813 (ORNL-RMIC-7(Rev.2)) BIBLIOGRAPHY OF MAGNETIC MATERIALS AND TABULATION OF MAGNETIC TRANSITION TEMPERATURES. Connolly, T. F.; Copenhaver, Emily D. (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 116p. Dep. CFSTI.

Two lists are presented alphabetically by material, one for Curie and one for Néel temperatures. This cumulative revision supersedes ORNL-RMIC-7 and ORNL-RMIC-7(Rev.) and is based on papers and reports received by RMIC through May 1970. A total of 1773 references is included. (D.L.C.)

42814 THEORY OF IMPURITY STATES IN SYSTEMS WITH LONG RANGE INTERACTIONS: SPIN WAVES IN Tb–Ho ALLOYS. Blackman, J. A. (Oxford Univ. Atomic Energy Establishment Risoe, Roskilde, Denmark). J. Phys. Chem. Solids; 31: 1573-85(Jul 1970).

The theoretical treatment of impurity problems is generally restricted to cases involving interactions of short range. The author presents here a discussion of the long-range case and shows how certain of the impurity terms may be treated exactly. One term remains intractable, however, but it is shown that, under some circumstances, this may to a good approximation be neglected. In particular, the spin-wave spectrum of the rare earth alloy Tb–Ho is considered, a system in which the angular momenta are coupled by the long-range Rudermann–Kittel interaction, and in which resonant magnon modes have been observed experimentally. A discussion is also given of the likely behaviour of spin waves in other Tb–rare earth alloys. (auth) (UK)

42815 ELECTRICAL PROPERTIES OF CERIUM HYDRIDES. Bos, William G. (Univ. of Louisville, Ky.). J. Chem. Phys.; 53: 855-6(15 Jul 1970).

The electrical properties of nonstoichiometric cerium hydride single crystals have been interpreted by Libowitz and Pack (J. Chem. Phys. 50: 3557(1969)) in terms of the hydridic model of bonding and a defect band arising from the overlap of octahedral hydrogen vacancy states. The nature of this defect band is examined by relating it to crystal-field splitting effects. The electron delocalization is attributed to the overlap between the Eg metal orbitals and the vacancy orbitals. Some conduction electron density is placed on the metal ions as well as the vacancy sites. (D.L.C.)

42816 DE HAAS–VAN ALPHEN EFFECT IN HCP YTTERBIUM. Tanuma, S.; Datars, W. R.; Doi, H.; Dunsworth, A. (McMaster Univ., Hamilton, Ont. Tokyo Univ.). Solid State Commun.; 8: 1107-10(15 Jul 1970).

The de Haas–van Alphen effect was measured in single crystals of ytterbium at 1.2°K in magnetic fields up to 116 kOe. The crystals, prepared by distillation, were found to be in either a hexagonal or a fcc phase at room temperature but only in the hexagonal phase after a cooling cycle to 1.2°K. The hexagonal phase is attributed to a hexagonal-close-packed structure reported previously for ytterbium at temperatures above 260°C. De Haas–van Alphen frequencies for the hcp principal planes and symmetry directions are reported. These results indicate hyperbolic sections of the Fermi surface of hcp ytterbium. (auth) (UK)

42817 PRESENT POSITION OF THEORY AND EXPERIMENT FOR VO_2. Paul, William (Harvard Univ., Cambridge, Mass.). Mater. Res. Bull.; 5: 691-702(Aug 1970).

The most important electrical and optical properties of VO_2 below and above the transition temperature between insulating and metallic behavior are analyzed to provide a few basic conclusions regarding the band structure and the transport mechanism. An argument is presented that electron–phonon interaction is the basic mechanism underlying the phase transition. (auth)

42818 MAGNETIC STRUCTURE OF MnB_2. Kasaya, Mitsuo; Hihara, Tadamiki (Tohoku Univ., Sendai). J. Phys. Soc. Jap.; 29: 336-42(Aug 1970).

Measurements of the ^{55}Mn nuclear magnetic resonance, high-field susceptibility, magnetic anisotropy, and electrical resistivity were performed on intermetallic compound MnB_2. It is proposed that MnB_2 is an antiferromagnet with a magnetic moment of about $3\mu_B$ per Mn atom and a Néel point of 760°K. The weak ferromagnetism below 157°K is attributed to the tilting of the antiferromagnetic moments out of the c plane. Unusual temperature dependence of the susceptibility and the mechanism for the tilting are discussed on the basis of the s–d exchange interaction. (auth)

42819 ELECTRONIC STRUCTURE OF THE URANIUM CARBONITRIDES $UC_{1-x}N_x$. De Novion, Charles-Henri (CEN, Fontenay-aux-Roses, France); Costa, Paul. Compt. Rend., Ser. B; 270: 1415-18(1 Jun 1970). (In French).

The magnetic susceptibility (between 4 and 900°K) and the specific heat (between 1.3 and 10°K) were measured for the solid solution $UC_{1-x}N_x$. Long-range magnetic order does not exist for $0.9 < x \leq 1$. The maximum electronic specific heat occurs when $x = 0.9$. (tr-auth) (France)

42820 DEBYE TEMPERATURE OF GRAPHITE SURFACES. Biberian, Jean-Paul; Bienfait, Michel (Univ., Marseille). Compt. Rend., Ser. B; 270: 1301-4(20 May 1970). (In French).

Using the dynamics of the crystal lattice, the Debye temperature in a direction normal to the (0001) face is calculated. The model used involves the interaction of noncentralized forces between nearest neighbors. The results obtained are in good agreement with an experimental determination using slow electron diffraction. (tr-auth) (France)

42821 BRILLOUIN ZONE BOUNDARIES EFFECT ON POSITRON ANNIHILATION IN MgO AND UO_2 CRYSTALS. Coussot, C.; Paulin, R. (Institut National des Sciences et Techniques

Nucleares, Saclay, France). J. Phys., C (London); 3: L100-2 (May 1970).

The experimental evidence for anomalies corresponding to the limits of the first Brillouin zone in the angular correlation curves resulting from positron annihilation in fcc MgO and UO_2 single crystals is reported. (auth) (UK)

42822 MAGNETICALLY ORDERED MATERIALS AT HIGH PRESSURES. Bloch, Daniel; Pavlovic, A. S. Advan. High Pressure Res.; 3: 41-154(1969).

A review with 283 references is presented. Experimental methods for magnetization measurements, the determination of magnetic structures, the measurement of the magnetocrystallographic anisotropy constants, the measurement of the magnetic ordering temperatures, theoretical thermodynamic relations, the molecular field model, and the indirect exchange model are examined. Data are assembled for MnO, FeO, CoO, MnS, $MnTe_2$, EuO, EuS, EuSe, EuTe, GeN, GdAs, the rare earth Fe garnets, Ni Zn ferrite, Mn Zn ferrite, α-Fe_2O_3, Cr_2O_3, $FeCl_2$, $FeBr_2$, $MnCO_3$, $CoCO_3$, MnF_2, $FeCl_2 \cdot 2H_2O$, $CoCl_2 \cdot 2H_2O$, MnTe, Gd, Tb, Dy, Ho, Er, Eu, Sm, Gd–rare earth alloys, Tb–rare earth alloys, Fe, Ni, Co, Cr, Fe alloys, Ni alloys, Cr alloys, MnAs, MnAu, MnBi, Mn_5Ge_3, MnP, MnSb, MnCrSb, the Heusler alloys, CrTe, Cr_3Te_4, $CrS_{1.17}$, α-FeS, and Sc_3In. (Selenium-Tellurium Abstr.)

42823 ELECTRICAL RESISTIVITY NEAR THE MAGNETIC TRANSITION OF SOME RARE-EARTH LAVES-PHASE COMPOUNDS. Kawatra, M. P.; Mydosh, J. A.; Budnick, J. I. (Fordham Univ., Bronx, N. Y.). Phys. Rev., B; 2: 665-70(1 Aug 1970).

From the measured temperature dependence of the electrical resistivity $\rho(T)$, the temperature derivative $d\rho/dT$ was computed with particular emphasis on its behavior in the critical region for six ferromagnetic rare-earth cubic Laves phase compounds: $GdAl_2$, $GdCo_2$, $GdNi_2$, $GdPt_2$, $GdRh_2$, and $DyAl_2$. All samples are characterized by pronounced changes in $d\rho/dT$ in the vicinity of the magnetic ordering temperature T_c. In $GdNi_2$, $GdPt_2$, and $GdRh_2$, as the temperature is decreased toward T_c, a minimum in $d\rho/dT$, followed by a maximum, is observed. This behavior is consistent with that predicted from the long-range nature of the short-range spin fluctuations in the framework of the molecular field theory. The behavior of $d\rho/dT$ for $GdAl_2$ and $DyAl_2$ shows only a broad maximum, whereas for $GdCo_2$, $d\rho/dT$ has a sharp peak at about T_c—very similar to that found in transition metals. (auth)

42824 CHANGE OF THE DIELECTRIC CONSTANT AT THE PHASE TRANSITION IN U_4O_9. Tateno, Jun (Japan Atomic Energy Research Inst., Tokai). Solid State Commun.; 8: 1043-5(1 Jul 1970).

The dielectric constant of U_4O_9 measured at 9.4 GHz changes at the phase transition point. ϵ' is 70 in the low-temperature phase and 260 in the high-temperature phase. This change is discussed on the basis of the electronic ordering of the phase transition. (auth) (UK)

42825 CONCERNING A BOUND NEUTRON IN MATTER. Kagan, Yu. JETP Lett. (USSR) (Engl. Transl.); 11: 147-51 (20 Feb 1970).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Red.; 11: 235-40 (20 Feb 1970).

An analysis is presented that demonstrates the possibility of the existence of a long-lived bound state of a neutron in matter. Such a state arises under certain conditions in an irregular medium at low temperature as a result of ordinary nuclear interaction when the collective effects of the medium are taken into account. (W.D.M.)

42826 ON F-ELECTRONS IN SOME UX COMPOUNDS. Fisk, Z.; Coles, B. R. (Imperial Coll. of Sciences and Tech., London). J. Phys., C (London); 3: L104-5(May 1970).

Published data strongly suggest that changes in the f-shell configuration of uranium in rock salt-type compounds occur as the composition is varied. (auth) (UK)

42827 MAGNETIC PLUTONIUM IMPURITIES IN PALLADIUM. Nellis, W. J.; Brodsky, M. B. (Argonne National Lab., Ill.). Phys. Lett.; 32A: 267-8(27 Jul 1970).

Electrical resistivity and magnetic susceptibility measurements on dilute Pd(Pu) and Pd(Np) alloys indicate that the two-band model cannot explain the resistivity of Kondo-type systems with positive resistivity-temperature slopes at low temperatures. (auth)

42828 MAGNETIC FIELD DEPENDENCE OF SPIN PHONON INTERACTION IN HOLMIUM. Levy, M.; Lee, M. C. (Univ. of California, Los Angeles). Phys. Lett.; 32A: 294-5(10 Aug 1970).

A broad maximum in spin phonon interaction is found in the spin spiral phase of holmium. In a magnetic field this maximum disappears; a new peak and a plateau appear at the intermediate phase transitions. (auth)

42829 SINGLE-ION ANISOTROPY BY INDIRECT EXCHANGE INTERACTIONS IN RARE-EARTH METALS. Kazakov, A. A.; Andreeva, R. I. (Urals State Univ., Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.): 12: 192-6(Jul 1970).

Translated from Fiz. Tverd. Tela; 12: 240-6(Jan 1970).

The Hamiltonian of indirect exchange via conduction electrons is calculated for the tight-binding approximation. The single-ion anisotropy energy derived from this Hamiltonian is shown to coincide to within an arbitrary factor with the anisotropy of the crystal field mechanism. The anisotropy constants are calculated as functions of temperature and atomic number on the basis of the molecular field approximation. The mean values of m^i for $i = 1, \ldots, 6$ are also calculated. (auth)

42830 MEAN FREE PATH OF THE CURRENT CARRIERS IN MOLYBDENUM. Boiko, V. V.; Gasparov, V. A. (Sukhumskii Physical-Technical Inst., USSR). Sov. Phys.-Solid State (Engl. Transl.); 12: 254-5(Jul 1970).

Translated from Fiz. Tverd. Tela; 12: 310-12(Jan 1970).

The radio-frequency size effect was used to measure l (mean free path) of electrons and holes in plane-parallel plates of Mo. The amplitude of the derivative with respect to the magnetic field of the resistive part of the surface impedance was measured as a function of thickness at 3.5 MHz and 4.2°K. The results show that $l_l = l_{hole} = 0.11 \pm 0.005$ mm, and that the ratio of relaxation times the Fermi surfaces is $\tau_l = l_{hole} = 1.5 \pm 0.3$. (D.L.C.)

42831 DECHANNELING OF FAST TRANSMITTED PARTICLES BY LATTICE DEFECTS. Delsarte, G.; Jousset, J. C.; Mory, J.; Quere, Y. (CEN, Fontenay-aux-Roses, France). pp 501-12 of Atomic Collision Phenomena in Solids. /Palmer, D. W. (ed.). London; North-Holland Publishing Company (1970).

From International Conference on Atomic Collision Phenomena in Solids, Brighton, England. See CONF-690957.

A method is described in which defects in crystals are obtained, using the transmission of particles emitted from an isotropic source in a foil of the material to be studied. When the foil is thick enough only those particles channeled in the crystal will emerge. If these emerging particles are picked up on a collector an image of the foil is produced, the contrast being due to differences in the conditions of channeling from one point of the sample to another. The contrast has two main origins: orientation (a region of a polycrystal having a wide open channel perpendicular to the foil delivers to the collector more particles than a region having no such channel) and obstruction (a region where channels are obstructed delivers to the collector fewer particles than a region of free channels). Orientation applies to the case of grains or twins, and obstruction to the case of grain (or twin) boundaries, stacking faults, dislocations, irradiation defects, and impurities. The dechanneling power was determined in the case of α particles for stacking fault tetrahedra in gold and dislocation loops in aluminum. Axial and planar channeling both play a role in the formation of the images. Planar channeling is responsible for the formation of the "channeling patterns" observed on the images inside of grains. These patterns were analyzed. They lead to a very simple method for orienting grains as small as 30 to 40 μ in a polycrystal. The method gives direct information on the conditions of channeling of different particles in all kinds of crystals. For instance, it was shown that fission fragments may be channeled along distances of the order of 10 μ in, say, platinum or tungsten. (18 references) (auth) (UK)

42832 ENERGY BANDS OF VO. Norwood, T. E.; Fry, J. L. (Louisiana State Univ., Baton Rouge). Phys. Rev., B; 2: 472-81 (15 Jul 1970).

A tight-binding calculation of the energy bands of VO has been performed for several different atomic configurations using all the valence and core orbitals from vanadium and oxygen as bases. All tight-binding integrals are accurately evaluated and all sums carried to convergence. Energy bands are found to be sensitive to the particular core states included and to the degree of ionicity assumed. Results for the band structure indicate that d bands are about 7 eV wide, lying below the vanadium 4s band, so that conductivity in VO is attributed primarily to d electrons. The Fermi energy falls in the d bands at a large peak in the density of states. (auth)

42833 EFFECT OF PRESSURE ON THE NEEL TEMPERATURE OF CHROMIUM–VANADIUM ALLOYS. de Dood, W.; de Dood, J.; de Chatel, P. F. (Univ., Amsterdam). Physica; 47: 337-44(5 Jun 1970).

The pressure dependence of the Néel temperature of chromium–vanadium alloys with less than 3 at. % vanadium was determined by electrical resistivity measurements under hydrostatic pressure up to 3000 atm. The Néel temperature of each alloy varies linearly with pressure in the observed range, with a slope proportional to its value at p = 0 atm. The results are interpreted using a model due to Rice, Halperin, Barker and McWhan. (auth)

42834 ENERGY LEVELS AND INTERACTION BETWEEN Eu^{3+} IONS AT LATTICE SITES OF SYMMETRY C_2 AND SYMMETRY C_{3i} IN Y_2O_3. Heber, J.; Hellwege, K. H.; Koebler, U.; Murmann, H. (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 237: 189-204(1970).

Besides the known energy levels of Eu^{3+} at lattice sites of symmetry C_2 and Y_2O_3, some transitions of this ion at lattice sites of symmetry C_{2i} in the same host crystal were found and it was possible to construct the energy level scheme in part. Evidence for an energy transfer from $Eu^{3+}(C_{3i})$ to $Eu^{3+}(C_2)$ is given, the strength of which is measured as a function of the Eu_2O_3 concentration. The results lead to the assumption of a fixed distance R_0 for the interaction responsible for the energy transfer. A temperature-independent value of R_0 = 8.7 Å was found. The full explanation of the underlying quantum-mechanical mechanism requires further experiments. (auth)

42835 DIELECTRIC PROPERTIES OF Y_2O_3 THIN FILMS PREPARED BY VACUUM EVAPORATION. Tsutsumi, Tadashi (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). Jap. J. Appl. Phys.; 9: 735-9(Jul 1970).

The dielectric films formed by evaporating Y_2O_3 in vacuum were identified as sesquioxide by infrared transmission, and electron and x-ray-diffraction studies. Thin-film capacitors using this dielectric material exhibit excellent electric stability in high temperature and can be reproduced easily in a closed-cycle process with electron beam equipment. The dielectric constant is 13 and dissipation factor, tan δ, is 0.003 at room temperature with a breakdown field strength of 3×10^6 V/cm. The temperature coefficient of Y_2O_3 film capacitor is about 300 ppm/°C. (auth)

Moessbauer Effects and NMR

42836 SPIN TEMPERATURE AND NUCLEAR MAGNETIC RESONANCE IN SOLIDS. Goldman, M. International Series of Monographs on Physics. Oxford; Clarendon Press (1970). 255p. 85s.

A unified description is presented of the high temperature approximation for spin-temperature theory and its chief applications to NMR in solids. Emphasis is on the twofold character of the theory: first as a branch of thermodynamics that exploits systematically the consequences of the fundamental hypothesis of the existence of a temperature within a spin system; and secondly as a practical tool that widens the possibilities of the use of NMR for the study of solid state physics. (UK)

42837 MOESSBAUER STUDY OF LOW-TEMPERATURE ANHARMONICITY IN ThO_2:^{57}Co. Shechter, H.; Dash, J. G.; Erickson, G. A.; Ingalls, R. (Univ. of Washington, Seattle). Phys. Rev., B; 2: 613-24(1 Aug 1970).

A detailed study of the Moessbauer effect of divalent ^{57}Fe impurities in ThO_2 shows several remarkable features. Although the most probable impurity sites have nearly cubic symmetry, the spectra have large quadrupole splittings (1.9–2.8 mm/sec). The Debye–Waller factor f is surprisingly low (0.3–0.4), nearly independent of temperature from room temperature to 10°K. The isomer shift (~1.0 mm/sec re metallic iron) is smaller than the usual value for divalent charge states. All three abnormalities can be explained through the assumption of effective potential wells of the impurities which have a "wine-bottle" shape. Quantitative comparisons based on a simplified "squared wine bottle" with a high central maximum yield an outer radius R_2 = 0.24 Å and inner radius R_1 = 0.19 Å. The empirical R_2 is comparable with an average "rattle radius" 0.26 Å corresponding to hard spheres with known ionic radii in the ThO_2 structure. Such a model yields f values in close agreement with observations at all temperatures, and a large negative thermal-shift contribution which provides a plausible explanation for the total observed shift. The central maximum of the assumed potential forces the impurity ions into positions of noncubic symmetry, offering a mechanism for the quadrupole splitting. The possibility of a relaxation process is suggested to account for the reduced magnitude of this splitting as well as for the broad lines. Theoretical analysis for f and the thermal shift in spherically symmetric wine-bottle potentials is given, and the occurrence of similar potentials in other impurity systems is discussed. (auth)

42838 NMR AND ELECTRON MICROSCOPY STUDIES ON [illegible] C.; [illegible], T.; Blake, T. S.; Penpraze, R. M.; Leider, H. R. (Univ. of California, Livermore). J. Phys. Chem. Solids; 31: 1461-6(Jul 1970).

Gamma-irradiated lithium hydride was studied with pulsed NMR and electron microscopy. Cubic voids were seen in the micrographs and were shown to be hydrogen gas bubbles. Formation of these bubbles caused LiH to swell as much as 25 volume per cent on irradiation. The average bubble size seems to be mainly a function of the irradiation temperature; the average size ranges from 80 to 1500 Å for irradiation temperatures between 120 and 265°C. Hydrogen gas in the bubbles gives rise to a motionally narrowed NMR signal. The longitudinal relaxation time T_1 appears to be a function only of the gas density, as is expected for gases. The transverse relaxation time T_{2m} is strongly affected by wall interactions and, therefore, decreases markedly with decreasing bubble size. (auth) (UK)

42839 MEASUREMENT OF SHORT NUCLEAR MAGNETIC RELAXATION TIMES IN LOW MAGNETIC FIELDS WITH SMALL SAMPLES. Kimmich, R.; Noack, F. (Univ., Stuttgart). Z. Angew. Phys.; 29: 248-53(1970). (In German).

The principles of operation and construction of a NMR pulse spectrometer for the investigation of magnetic relaxation in low Zeeman fields from about 1 to 176 Oe are described. Both longitudinal and transversal relaxation times can be measured. The spectrometer is distinguished by its capability to investigate fast relaxation processes ($T_1 \geq 6$ msec) with small samples (≈12 cm^3). (auth)

Theoretical Physics

Refer also to abstracts 42687 and 42688.

42840 (INP–705) STRUCTURE FACTOR AND EXCITATION SPECTRUM OF THE MANY-BODY SYSTEM CALCULATED BY THE DECOUPLING OF GREEN FUNCTION. Parlinski, K. (Institute of Nuclear Physics, Krakow (Poland)). 1970. 19p. Dep. CFSTI (U. S. Sales Only).

Using the method of retarded Green function, the system of self-consistent equations for the radial distribution function and the excitation spectrum of a many-body system are found. The simplest approximation is used, in which the elementary excitations are not damped. The Feynman relation for the structure factor, and the Hubbard–Beeby formulas of the self-energy spectrum of collective excitations in liquids is involved in this system. The properties of classical and quantum liquids are described qualitatively. (auth)

42841 (ITF–70-27) ON THE GENERATING OPERATOR FOR GREEN'S FUNCTIONS EQUATIONS. Ivanov, S. S. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 22p. Dep. CFSTI (U. S. Sales Only).

Investigation of Green's functions equations in the Euclidean domain was carried out. Based on the interesting analogy between the interaction Hamiltonian and the generating operator of these equations, one proves uniqueness of solving the smoothing equations for the imaginary values of the coupling constant g. A short investigation was made of the transition probability into the real domain over the coupling constant. (auth)

42842 (NP–18350) ON THE TIME-DEPENDENT HARMONIC OSCILLATOR. Note No. 256. Salusti, E. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)); Zirilli, F. (Rome Univ. (Italy). Istituto di Fisica). 10 Feb 1970. 8p. Dep. CFSTI (U. S. Sales Only).

An operator A(x, ∂/∂x, t) is introduced with the property that, once applied to a solution of the Schroedinger equation, it gives another solution. The explicit form of this operator A is obtained by means of a simple differential equation with one and only one solution. (M.O.W.)

42843 (NYO–3829-54) NONLINEAR EFFECTS IN QUANTUM ELECTRODYNAMICS. PHOTON PROPAGATION AND PHOTON SPLITTING IN AN EXTERNAL FIELD. Bialynicka-Birula, Z.; Bialynicki-Birula, I. (Pennsylvania Univ., Philadelphia. Dept. of Physics). [1970]. Contract AT(30-1)-3829. 21p. Dep. CFSTI.

The effective nonlinear Lagrangian derived by Heisenberg and Euler is used to describe the propagation of photons in slowly varying but otherwise arbitrary electromagnetic fields. The group and the phase velocities for both propagation modes are calculated and it is shown that the propagation is always causal. The photon splitting processes are also studied and it is shown that they do not play any significant role even in very strong magnetic fields surrounding neutron stars. (auth)

42844 RELATIVISTIC BEHAVIOUR OF MOVING TERRESTRIAL CLOCKS. Hafele, J. C. (Washington Univ., St. Louis). Nature (London); 227: 270-1(18 Jul 1970).

It has been shown that insofar as the Earth assumes the shape of the geoid and weak tidal fields can be neglected, its entire surface is an "equal time" surface. An interesting question that arises is —what would be the rate of a standard clock moving relative to stationary standard clocks on the geoid. The standard answer that moving clocks run slow by the factor $(1-v^2/c^2)^{\frac{1}{2}}$ is almost certainly incorrect. According to relativity theory a clock records proper time, and in the present context the interest is in finding the proper time for a body that is moving in a time-independent permanent gravitational field. The case is considered of an airborne clock at an altitude directly above the equator and moving either directly East or West, and equations are given for the time intervals of this clock and a ground based reference clock relative to an imaginary background system of coordinate clocks. Only proper time is recorded by real clocks, however; coordinate time is not recorded. This unknown coordinate time can be eliminated from the equations. The resulting equations predict that an airborne clock may run fast or slow relative to a ground based reference clock, depending on the sign of v. This directional dependence reflects the prediction of relativity theory that the relative rate of two clocks does not depend solely on the relative speed when both clocks experience acceleration. Aircraft ground speeds are now great enough that this directional dependence should be appreciable with modern portable atomic clocks; the case of a jet plane carrying such a clock is considered. When time standards in world laboratories are intercompared by transporting portable standards between them any relativistic time corrections arising from transit would need to take into account these directional effects. (UK)

42845 REMARK ON PHASE-SPACE DISTRIBUTIONS IN QUANTUM THEORY. Pechukas, Philip (Columbia Univ., New York). J. Chem. Phys.; 53: 658-9(15 Jul 1970).

If the choice is limited to quadratic forms, it is impossible to find representations of quantum states by positive distributions on phase space, either in the ordinary or in an extended "coarse-grained" sense. (auth)

42846 EXCHANGE POTENTIALS IN A NONUNIFORM ELECTRON GAS. Overhauser, A. W. (Ford Motor Co., Dearborn, Mich.). Phys. Rev., B; 2: 874-6(15 Aug 1970).

Off-diagonal matrix elements of the exchange operator are computed for a degenerate electron gas having a small sinusoidal density modulation. The extreme nonlocal character of exchange is shown explicitly by its wave-vector dependence. The Slater exchange approximation severely underestimates the off-diagonal action of the exact exchange operator (by a numerical factor approaching ∞ for long-wavelength modulations). Such errors are largely compensated by neglect of the correlation potential. (auth)

42847 RADIATION OF A RELATIVISTIC CHARGE IN A PLANE WAVE ELECTROMAGNETIC FIELD. Ternov, I. M.; Bagrov, V. G.; Khapaev, A. M. (Moscow State Univ.). Ann. Phys. (Leipzig); 22: No. 1-2, 25-32(Nov 1968).

The radiation of a charge moving in the field of a plane circularly polarized electromagnetic wave is discussed by the methods of classical and quantum theory both for a zero-spin particle (boson) and for an electron. Such considerations allow one to analyze the role of quantum and spin effects on the radiation. It is shown that the present problem has deep analogies with the problem of the synchrotron radiation. From this point of view many physical features of Compton radiation are represented as simple consequences of the classical or quantum theory of synchrotron radiation. (auth)

42848 CLASSICAL MECHANICS AS A LIMIT OF QUANTUM MECHANICS. Schroeter, J. (Philipps-Univ., Marburg, Ger.). Ann. Phys. (Leipzig); 23: 15-27(Jun 1969).

A formulation of classical mechanics is given with the help of linear operators in Hilbert space, which is different from the formalism of v. Neumann and Koopman, i.e., the observables are represented by self-adjoint operators instead of real functions. It is shown that classical mechanics in this form fulfills the same axioms as quantum mechanics except those two ones which contain $\hbar$. But the corresponding classical axioms are obtained from the quantum-mechanical ones by substituting $\hbar$ with 0. (auth)

42849 ANALOGY BETWEEN THE EQUATIONS OF SPIN WAVES AND THOSE OF WAVE MECHANICS. Kaliski, S. Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 18: 275-6(1970).

There is an analogy between the linearized equations of propagation of spin waves and the Schroedinger equation. This analogy is demonstrated in the present communication. (auth)

42850 OPERATIONAL APPROACH TO QUANTUM PROBABILITY. Davies, E. B. (Massachusetts Inst. of Tech., Cambridge); Lewis, J. T. Contract F 44620-67-C-0029. Commun. Math. Phys.; 17: 239-60(1970).

In order to provide a mathematical framework for the process of making repeated measurements on continuous observables in a statistical system, a mathematical definition was made of an instrument, a concept which generalizes that of an observable and that of an operation. It is then possible to develop such notions as joint and conditional probabilities without any of the commutation conditions needed in the approach via observables. One of the crucial notions is that of repeatability which is implicitly assumed in most of the axiomatic treatments of quantum mechanics, but whose abandonment leads to a much more flexible approach to measurement theory. (auth)

42851 NOTE ON RING INTEGRALS AND THE FERMI FUNCTION. Papadopoulos, G. J.; Jones, A. V. (Univ. of Leeds, Eng.). J. Phys., A (London); 3: 342-5(Jul 1970).

A method which proceeds in a natural fashion via the symmetry properties of the wave functions of a many-body fermion (boson) system of independent identical particles, was employed for the derivation of the Fermi (Bose) function. The analysis makes use of the grand partition function expressed in terms of ring integrals. Spin considerations are included in the case of electrons in a constant uniform magnetic field. (auth) (UK)

42852 EXPANSION OF THE MASTER EQUATION WITH APPLICATIONS TO COUPLED ATOM–RADIATION SYSTEMS. Pike, E. R.; Swain, S. (Royal Radar Establishment, Great Malvern, Eng.). J. Phys., A (London); 3: 346-56(Jul 1970).

A straightforward extension of time-dependent quantum-mechanical perturbation theory is made to obtain the equivalent formulas for statistical mixture of states. The 'master equation' resulting from this procedure is, in its lowest order, the analogue in quantum statistics of the 'Golden Rule' for transition rates and reduces exactly to this form in the limit of pure initial states. Results were given to fourth order and their use illustrated by applying them to the problem of the resonant interaction of an electromagnetic field and a two-level atom. (auth) (UK)

42853 FUNDAMENTAL PRINCIPLES OF MODERN THEORETICAL PHYSICS. Furth, R. H. International Series of Monographs in Natural Philosophy. Volume 24. Oxford; Pergamon Press (1970). 366p. 90s.

The following topics are discussed: Quantum theory (fundamental principles of classical physics; history of development of quantum theory; principles of Schroedinger's wave mechanics; eigenfunctions and eigenvalues of the wave equation; application of quantum mechanics to simple problems of atomic physics; non-stationary phenomena; operator and matrix mechanics; many-particle problems); relativity theory (classical principle of relativity; special theory; connections between special theory and quantum theory; elements of general theory); statistical mechanics (theory of ensembles; statistical mechanics of assemblies; some applications of statistical mechanics). Some problems and answers are included. (UK)

42854 FOUNDATIONS OF CLASSICAL AND QUANTUM STATISTICAL MECHANICS. Jancel, R. International Series of Monographs in Natural Philosophy. Volume 19. Elmsford, N. Y.: Pergamon Publishing Company (1969). 439p. $16.00.

Translation of Les Fondements de la Mecanique Statistique Classique et Quantique by W. E. Jones

The following chapters are included: (1) the ergodic theory in classical statistical mechanics, (2) quantum mechanical ensembles; macroscopic operators, (3) the ergodic theorem in quantum statistical mechanics, (4) probability quantum ergodic theorem, (5) H-theorems and kinetic equations in classical statistical mechanics, (6) H-theorems and kinetic equations in quantum statistical mechanics, and (7) general conclusions, macroscopic observation and quantum measurement. (M.O.W.)

42855 ENGINEERING QUANTUM ELECTRODYNAMICS. Marcuse, Dietrich. Harbrace Series in Electrical Engineering. New York; Harcourt, Brace and World, Inc. (1970). 475p. $16.95.

The following chapters are given: (1) review of quantum mechanics, (2) field quantization, (3) interactions between fields and charges, (4) photon emission by free electrons, (5) interaction of bound electrons with radiation, (6) noise and counting statistics, (7) the density matrix method, (8) multiple-photon losses, and (9) losses in quantum electronics. (M.O.W.)

42856 WIGNER REPRESENTATION OF A QUANTUM-MECHANICAL SYSTEM WITH ROTATIONAL DEGREES OF FREEDOM. I. Nienhuis, G. (Univ., Utrecht). Physica; 47: 425-41(5 Jun 1970).

A Wigner representation of a quantum-mechanical system consisting of a rotator with one moment of inertia only is presented; this means that for every operator of this system a corresponding phase function is defined, in such a way that the trace of the operator can be written as the phase integral of this phase function. In the case of a canonical ensemble a Wigner distribution function is defined and its series expansion in $\hbar^2$ is derived up to the first order. The equation of motion of Heisenberg operators is given in Wigner representation. (auth)

42857 WIGNER REPRESENTATION OF A QUANTUM-MECHANICAL SYSTEM WITH ROTATIONAL DEGREES OF FREEDOM. II. Nienhuis, G. (Univ., Utrecht). Physica; 47: 442-51(5 Jun 1970).

A quantum-mechanical system consisting of rigid bodies with three different moments of inertia (asymmetric top) is considered. Recently St. Pierre and Steele introduced a Wigner distribution function for this system. In this paper, a Wigner equivalent corresponding to an arbitrary quantum-mechanical operator of this system is defined in a somewhat more explicit way. It is shown that the trace of an operator can be replaced by the phase-space integral of its Wigner equivalent, and the way in which the product of two operators can be written as a phase-space integral is given. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

42858 (COO–1749-18) RESEARCH PROGRAM IN HIGH ENERGY ACCELERATOR PHYSICS AND LOW LEVEL COUNTING ELEMENTARY PARTICLE PHYSICS. Technical Report, October 1, 1969–September 30, 1970. Frisken, William R.; Jenkins, Thomas L.; Sullivan, Charles R.; Smith, William M.; Strelzoff, Alan G. (Case-Western Reserve Univ., Cleveland, Ohio). Jun 1970. Contract AT(11-1)-1749. 23p. Dep. CFSTI.

Research on $\pi^- + p$ charge exchange, proton stability, and double beta decay is summarized. A list of publications is included. (J.F.P.)

42859 GRAVITATIONAL RADIATION EXPERIMENTS. Weber, J. (Univ. of Maryland, College Park). pp 133-43 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

A description is given of the gravitational radiation experiments involving detectors at opposite ends of a 1000 kilometer baseline, at Argonne National Laboratory and the University of Maryland. Sudden increases in detector output are observed roughly once in several days, coincident within the resolution time of 0.25 seconds. The statistics rule out an accidental origin and experiments rule out seismic and electromagnetic effects. It is reasonable to conclude that gravitational radiation is being observed. (auth)

42860 GENERAL RELATIVITY EXPERIMENTS USING LOW TEMPERATURE TECHNIQUES. Everitt, C. W. F.; Fairbank, William M.; Hamilton, William O. (Stanford Univ., Calif.). Contract AF33(615)67C-1245. pp 145-59 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

Experiments to test the Einstein theory of general relativity are described. The experiments in which a satellite and gyroscopes are used, are made possible by complete use of a low-temperature environment and the properties of superconductors including the use of zero magnetic fields and ultrasensitive magnetometry. (J.F.P.)

42861 COMMENTS ON EVIDENCE OF A QUARK IN A HIGH-ENERGY COSMIC-RAY BUBBLE-CHAMBER PICTURE. Allison, W. W. M.; Derrick, M.; Hunt, G. P.; Simpson, J. D.; Voyvodic, L. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 25: 550-3(24 Aug 1970).

It is found that the "quark" track recently reported by Chu et al. can be simply explained in terms of a normally charged cosmic ray entering the bubble chamber at an early time. (auth)

Electromagnetic

42862 (SLAC-109) BACKWARD PHOTOPRODUCTION OF π^0 MESONS AT 6 TO 18 GeV. Tompkins, Donald H. (Stanford Linear Accelerator Center, Calif.). Jul 1970. Contract AT(04-3)-515. 105p. Dep. CFSTI.

Differential cross sections for π^0 photoproduction at backward angles were measured in the momentum transfer range $u = 0$ to -1 $(GeV/c)^2$, for incident photon energies of 6, 8, 12 and 18 GeV. A collimated bremsstrahlung beam from the Stanford linear accelerator was passed through a 40-in.-long liquid-hydrogen target, and the momentum spectrum of the forward moving protons was measured in the SLAC 20 GeV/c magnetic spectrometer. Single pion production is separated from other processes on the basis of kinematics and the spectrum shape. (auth)

42863 STUDY OF THE ϕ MESON BY e^+e^- ANNIHILATION INTO CHARGED K MESONS AND TESTS OF VECTOR DOMINANCE MODELS. Bizot, J. C.; Buon, J.; Chatelus, Y.; (and others) (Ecole Normale Superieure, Orsay, France). Phys. Lett.; 32B: 416-20(3 Aug 1970).

The $e^+e^- \rightarrow \phi$ reaction was measured by its K^+K^- decay mode. Using previous results on $K^0\bar{K}^0$ and the 3π decay mode of the ϕ mesons, $\Gamma_{\phi \rightarrow e^+e^-}$ is computed and then the whole Orsay results are compared to theoretical predictions. (auth)

42864 MEASUREMENT OF THE COSMIC-RAY GAMMA-RAY ENERGY SPECTRUM AT BALLOON ALTITUDES. Staib, Jon Albert. Cleveland; Case Western Reserve Univ. (1969). 82p. Thesis.

A method is presented for measuring a gamma-ray energy spectrum by observing the scattering of electron positron pairs in a thin-plate, multi-gap chamber. The quantity of scattering measurement was the second difference of the lateral displacements. Calculations are presented which show the dependence of the average second difference, $\langle\beta\rangle$, on the electron energy, E, the inclination angle, Θ, and the cell length, n. The result is $\langle\beta\rangle \propto E^{-1}n^{1.56}\Theta^{2.55}$. The cell length is the number of gaps between successive measurements of the lateral displacements. Scattering measurements on known energy electrons showed good agreement with this relation for inclination angles below 25 degrees. A calculation is described for obtaining the measured electron energy spectrum from an incident gamma-ray spectrum. This calculation makes corrections for those pairs not resolved by the spark chamber. Again good agreement is observed between this calculation and measurements made on known energy pairs. Finally, the devised method is used to determine the energy spectrum of gamma-rays observed over Mildura, Australia at an altitude of about 2.5 mbar and vertical magnetic cutoff of 4.0 GeV. Assuming the spectrum to be of the form $N(E) \propto E^{-x}$, the values of x were determined to be 1.45 ± 0.15 in the 70 MeV to 1 BeV range, 1.30 ± 0.20 in the 70 MeV to 250 MeV range, and 1.70 ± 0.30 in the 250 to 1 BeV range. (Diss. Abstr. Int., B)

42865 POLARIZATION PHENOMENA IN $\gamma\gamma \rightarrow e^+e^-$ REACTION AND ITS POSSIBLE EXPERIMENTAL STUDY. Ispiryan, K. A.; Nagorskaya, I. A.; Oganesyan, A. G.; Khoze, V. A. Yadern. Fiz.; 11: 1278-83(Jun 1970). (In Russian).

Polarization phenomena in the electron-positron pair conversion of two photons are considered. A general formula is obtained, and some of its particular cases are analyzed. Two ways to study the reaction in experiment are proposed. (auth)

42866 POLARIZATION OF THE RECOIL PROTON FROM THE PROCESS $\gamma \rightarrow \pi^-$ IN DEUTERIUM FOR $(\theta\ \pi)_{c.m.} = 90^\circ$ IN THE SECOND-RESONANCE REGION. Beneventano, M.; d'Angelo, S.; de Notaristefani, F.; Monacelli, P.; Paoluzi, L.; Sebastiani, F.; Severi, M.; Stella, B. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). Lett. Nuovo Cim.; 3: 840-4(27 Jun 1970).

The polarization of the recoil proton from the process $\gamma + n \rightarrow p + \pi^-$ in deuterium in the energy range 515 to 714 MeV was measured. Plastic scintillation counters and spark chambers were used in this study. (J.F.P.)

Weak

Refer also to abstracts 42889 and 43046.

42867 EXPERIMENTAL EVIDENCE AGAINST A NON-STRONGLY INTERACTING CP-EVEN K_L^0 COMPONENT. Buchanan, C. D. (Univ. of California, Los Angeles); Chien, C. Y.; Cox, B.; (and others). Phys. Lett.; 32B: 396-8(3 Aug 1970).

The rate for $K_L^0 \rightarrow \pi^+\pi^-$ was measured as a function of the thickness of lead absorber placed in a K_L^0 beam at SLAC. Measurements were made with 12", 18" and 24" of lead. The results, which are relatively constant, are in strong disagreement with models which ascribe this decay mode to an additional neutral meson state which is CP even, does not interact strongly, but otherwise has properties similar to the K_2^0 state. (auth)

42868 SEARCH OF (V + A) CURRENTS IN EXPERIMENTS WITH HIGH ENERGY NEUTRINOS. Mikheev, N. V.; Kaganovich, A. B. (Volgograd State Pedagogical Inst.). Yadern. Fiz.; 11: 1265-7(Jun 1970). (In Russian).

The calculation results are given of relative value of cross sections in experiments with high energy neutrino of the positron and muon production from K and π decays in flight in the weak interaction model with violated $(V \mp A)$ symmetry. The number of events of neutrino spectra in the CERN and Serpukhov experiments is estimated. (auth)

Strong (Baryon-Induced)

42869 (UCRL–19832) THE SEARCH FOR Z*'s. Goldhaber, Gerson (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1970. Contract W-7405-eng-48. 19p. (CONF-700416-7). Dep. CFSTI.

From International Conference on Hyperon Resonances, Durham, N. C.

In the discussion of the existence and observation of Z* three previous works are summarized. These are $K^+ + p$ elastic scat-

tering measurements from 1.4 to 2.3 GeV/c, Regge pole analysis, and K* production from the I = O K*N state. The present status on the Z* is discussed. (J.F.P.)

42870 (UCRL-50848) AN ANALYSIS OF A PROPOSED n-n SCATTERING EXPERIMENT. Dickinson, W. C.; Lent, E. M.; Bowman, C. D. (California Univ., Livermore. Lawrence Radiation Lab.). 1 Apr 1970. 88p. Dep. CFSTI.

The various experimental parameters affecting a proposed measurement of the neutron-neutron scattering cross-section in a high-flux pulsed nuclear reactor are investigated. In calculating neutron production rates, one assumes first a velocity-dependent isotropic neutron distribution in the reactor cavity and, second, a single-velocity anisotropic distribution. Also neutron production rates are calculated for neutron scattering from a calibration gas that could be placed in the cavity. Expressions are given for the distribution of neutron arrival times at the n-n detector. The effect of experimental geometry on n-n counting rate is considered, and also an optimum geometry for the experiment is proposed. A fairly accurate expression is given for calculating the number of n-n scattered neutrons counted per reaction pulse, along with an error analysis of the experiment. (auth)

42871 FIREBALL WITH TRANSVERSE MOMENTUM IN THE ICEF 440 JET. Agnese, A.; La Camera, M.; Wataghin, A. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Lett. Nuovo Cim.; 4: 113-16(18 Jul 1970).

An improved fireball model, which takes into account the emission angle of the fireball, is used to analyze the ICEF 440 (4 + 8p) jet measured previously. (J.F.P.)

42872 SCALING BEHAVIOR IN $pp \rightarrow \pi$ + ANYTHING AT HIGH ENERGY. Bali, N. F.; Brown, Lowell S.; Peccei, R. D.; Pignotti, A. (Univ. of Washington, Seattle). Phys. Rev. Lett.; 25: 557-60(24 Aug 1970).

Evidence that the inclusive reaction $p + p \rightarrow \pi$ + anything approaches a scaling limit at accelerator energies is presented. (auth)

42873 ANGULAR DISTRIBUTION OF 24-MeV NEUTRONS SCATTERED BY PROTONS. Rothenberg, L. N. (Univ. of Wisconsin, Madison). pp 163 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25-30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).

See CONF-690804.

42874 ISOTOPIC-SPIN DEPENDENCE OF $\bar{N}N$ ANNIHILATION UP TO 5.5 GeV/c. Camerini, U.; Cline, D.; Ling, T.; Rutz, R. (Univ. of Wisconsin, Madison). Contracts AT(11-1)-881; COO-881-186. Nuovo Cim.; 68A: 686-90(21 Aug 1970).

The ratio of I = 1 to I = 0 $\bar{N}N$ annihilation cross sections was determined at 1.33 and 5.5 GeV/c incident $\bar{N}$ momentum using $\bar{p}d$ exposures at these momenta. In order to separate the annihilation cross section from the π production cross section at 5.5 GeV/c a detailed topological comparison was made between the $\bar{p}d$ and the $\bar{p}p$ results of Bockmann et al. The annihilation process appears to be strongly isotopic-spin dependent over this momentum range. The ratio of $\sigma(I = 1)/\sigma(I = 0)$ is also consistent with the value measured for stopping $\bar{p}$ in D_2. (auth)

42875 INTERACTION OF RELATIVISTIC HEAVY NUCLEI FROM COSMIC RAYS WITH NUCLEAR EMULSION. Gagarin, Yu. F.; Ivanova, N. S.; Kulikov, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 11: 1255-64(Jun 1970). (In Russian).

The main properties are obtained for 365 interaction events of heavy cosmic nuclei from the groups M($z = 6$ to 9) and H($z \geq 10$) in nuclear emulsion. Dependence on the target nucleus mass and the collision parameter was investigated. The smaller the collision parameter and the higher the number of the interacting nucleons, the more different is the process from the nucleon-nucleus process. Particular properties of the nuclear interactions are most evident in collisions with such numbers of grey and black tracks, that $N_{gr} + N_{bl} \geq 28$. The observed properties contradict the model of independent superposition of the nucleon-nucleus interactions and may be explained with account of many-particle interactions and of decrease of the nucleon density in the nucleus while the cascade proceeds. (auth)

Strong (Meson-Induced)

42876 (COO-1195-194) BACKWARD f^0 PRODUCTION IN $\pi^+d \rightarrow pp\pi^+\pi^-$ AT 4.19 GeV/c. Eisenstein, B.; Gordon, H. (Illinois Univ., Urbana. Dept. of Physics). Jul 1970. 12p. Dep. CFSTI.

Backward f^0 production was observed in the reaction $\pi^+d \rightarrow pp\pi^+\pi^-$ at 4.19 GeV/c. The f^0 decay angular distribution is consistent with production by elementary nucleon exchange in the u-channel. No structure is seen, within the limit of the statistics, in $d\sigma/du$. (auth)

42877 (COO-1428-232) STUDY OF Δ^{++} PRODUCTION IN TWO PRONGED π^+p INTERACTIONS AT 13.1 GeV/c. Scharenguivel, J. H.; Barton, H. R. Jr.; Gutay, L. J.; Kramer, S. L.; Lichtman, S.; Miller, D. H. (Purdue Univ., Lafayette, Ind.). [1969]. 13p. (CONF-700806-26). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR

The production and decay angular distributions of the reactions $\pi^+p \rightarrow \pi^0\Delta^{++}$ and $\pi^+p \rightarrow \eta^0\Delta^{++}$ were studied. The data came from a sample of 70K two-pronged events at 13.1 GeV/c incident π^+ momentum. (auth)

42878 (NYO-3651-13) STUDY OF $Y_1^*(1385)\pi$ PRODUCTION NEAR THE $Y_0^*(1520)$ RESONANCE. Chan, Shu-bon (Massachusetts Univ., Amherst); Schiff, M. (Yale Univ., New Haven, Conn.); Berley, D.; (and others) (Brookhaven National Lab., Upton, N. Y.). Apr 1970. 5p. (CONF-700416-6). Dep. CFSTI.

From International Conference on Hyperon Resonances, Durham, N. C.

The production of $\Sigma(1385)$ in $K^- + p \rightarrow \Lambda + \pi^+ + \pi^-$ interactions at 375 and 415 MeV/c was studied near the $\Lambda(1520)$. The purpose of the experiment was to determine to what extent the production of $\Sigma(1385)$ derives from the $\Lambda(1520)$ decay. (J.F.P.)

42879 (UCR-34-P-107-104) ANNUAL REPORT [ON HIGH ENERGY PHYSICS]. Kernan, A.; Poe, R. T. (California Univ., Riverside). May 1970. Contract AT(04-3)-34. 19p. Dep. CFSTI.

A brief summary of research on π^+p and K^-p interactions, high energy phenomenology, and diffraction dissociation in π^-d interactions is presented. (J.F.P.)

42880 (UH-511-74-70) MEASUREMENT OF $\pi\pi$ INELASTIC SCATTERING CROSS-SECTION IN THE REGION OF 1 GeV INVARIANT MASS. Hyams, B. D. (European Organization for Nuclear Research, Geneva (Switzerland)); Beusch, W. (Eidgenoessische Technische Hochschule, Zurich (Switzerland)); Johnson, A. D.; (and others) (Hawaii Univ., Honolulu). [1970]. 18p. (CONF-700525-5). Dep. CFSTI

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa.

The cross section of the interaction $\pi^- + \pi^+ \rightarrow K^+ + K^-$ was studied in the interaction $\pi^- + p \rightarrow K^+ + K^- + n$ at 11 GeV/c. The cross section of the interaction $\pi^- + \pi^+ \rightarrow K_1^0 + K_1^0$ was studied in the interaction $\pi^- + \pi^+ \rightarrow K_1^0 + K_1^0 + n$ at 6 and 12 GeV/c. And lastly the cross section of the interaction $\pi^- + \pi^+ \rightarrow 2\pi^+ + 2\pi^-$ was studied in the interaction $\pi^- + p \rightarrow 2\pi^+ + 2\pi^- + n$ at 3.9 GeV/c. It is found that the $\pi + \pi T = 0$ s-wave scattering becomes highly inelastic within the first 30 MeV above the $K\bar{K}$ threshold. (J.F.P.)

42881 EVIDENCE FOR STRUCTURE IN THE f^0 AND g^0 DIPION MASS REGIONS. Stuntebeck, P. H.; Kenney, V. P.; Deery, B. J.; Biswas, N. N.; Cason, N. M.; Dzierba, A. R.; Farber, M. S.; Poirier, J. A.; Shephard, W. D. (Univ. of Notre Dame, Ind.). Phys. Lett.; 32B: 391-5(3 Aug 1970).

The combined dipion mass spectrum for 3969 events from the reactions $\pi^-p \rightarrow n\pi^+\pi^-$ (8 GeV/c) and $\pi^+d \rightarrow pp\pi^+\pi^-$ (5.4 GeV/c) was studied for evidence of structure in the f^0 and g^0 mass regions. There appears to be a 4-standard deviation dip in the f^0 peak at ~1240 MeV, although the data are not inconsistent with the assumption of a single f^0 resonance. Two distinct peaks were resolved in the g^0 region, at 1655 ± 4 MeV and 1764 ± 15 MeV, indicative of I = 1 and I = 0 resonances, respectively. The lower-mass peak is narrow ($\Gamma = 20 \pm 8$ MeV) and is enhanced when events with low four-momenta are selected. (auth)

42882 STUDY OF $K^-\pi^-$ SCATTERING USING THE REACTION $K^-d \rightarrow K^-\pi^-pp$. Cho, Y. (Argonne National Lab., Ill.); Derrick, M.; Johnson, D.; Musgrave, B.; Wangler, T.; Wong, J.; Davis, R.; Werner, B.; Ammar, R.; Kropac, W.; Yarger, H. Phys. Lett.; 32B: 409-12(3 Aug 1970).

Approximately 700 events of the reaction $K^-d \rightarrow K^-\pi^-pp_s$, produced by 5.5 GeV/c kaons were used to measure the cross section for $K\pi$ elastic scattering in the $T = 3/2$ state by a Chew-Low extrapolation. The cross section does not exceed 2.1 mb and has no structure for $K\pi$ masses from threshold up to 2.0 GeV. (auth)

42883 π^+p HIGH-ENERGY TOTAL CROSS-SECTIONS AND DEUTERON SHADOW. Alberi, G. (Univ., Trieste, Italy); Bertocchi, L.; Soper, P. J. R. Phys. Lett.; 32B: 367-9(3 Aug 1970).

The extraction of σ_{π^+p} from the Serpukhov measurements of σ_{π^-p} and σ_{π^-d} is re-examined in the light of experimental information about the cross-section defect. (auth)

42884 MEASUREMENTS OF THE NATURAL LINE WIDTH AND ENERGY SHIFT OF THE K-MESONIC 4f → 3d TRANSITION IN SULPHUR. Backenstoss, G.; Bamberger, A.; Egger, J.; Hamilton, W. D.; Koch, H.; Lynen, U.; Ritter, H. G.; Schmitt, H. (CERN, Geneva. Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger. Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett.; 32B: 399-403(3 Aug 1970).

The natural line width Γ and an energy shift ΔE due to the strong K-meson-nucleus interaction was observed for the first time, for an x-ray transition of a K-mesonic atom. For the sulfur 4f–3d transition Γ = (2.2 ± 0.6) keV and ΔE = (–0.36 ± 0.25) keV was measured. (auth)

42885 INTERMEDIATE-ANGLE PION–PROTON ELASTIC SCATTERING FROM 3.0 TO 5.0 GeV/c. Brabson, B. B.; Crittenden, R. R.; Heinz, R. M.; Kammerud, R. C.; Neal, H. A.; Paik, H. W.; Sidwell, R. A. (Indiana Univ., Bloomington). Contract AT(11-1)-2009. Phys. Rev. Lett.; 25: 553-7(24 Aug 1970).

Differential cross-section measurements for π^+p and π^-p elastic scattering at 3.0, 3.5, 4.0, and 5.0 GeV/c are presented for center-of-mass scattering angles between 55° and 130°. A shoulder near $t = -0.9$ and a dip near $t = -3.0$ $(GeV/c)^2$ are seen in the data throughout this momentum range. (auth)

42886 RELATIVE VALUES OF THE CROSS SECTIONS FOR THE REACTIONS NN → W + (HADRONS) AND NN → (HADRONS) + γ → (HADRONS) + $\mu^+ + \mu^-$. Folomeshkin, V. N. (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 11: 1268-71(Jun 1970). (In Russian).

Possible background from muon pairs produced by electromagnetism in experiments on search of W bosons in NN collisions is estimated. (auth)

42887 STUDY OF CHANNELS OF REACTION $\pi^-p \rightarrow n2\pi^+2\pi^-m\pi^0$ AT 4 GeV/c. Grishin, V. G.; Kopylova, D. K.; Lyubimov, V. B.; Petrzhilka, V. V.; Suk, M.; Trka, Z.; Trkova, Ya.; Yuldashev, B. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 1242-7(Jun 1970). (In Russian).

The reaction $\pi^-p \rightarrow n2\pi^+2\pi^-m\pi^0$ at 4 GeV/c was studied by means of a 24 liter propane chamber of the High Energy Laboratory of Joint Institute of Nuclear Research. There were 150,000 photographs scanned and 401 events found. The following cross sections were determined: $\sigma(\pi^-p \rightarrow n2\pi^+2\pi^-\pi^0) = (1.21 \pm 0.12)$ mbn, $\sigma(\pi^-p \rightarrow n2\pi^+2\pi^-2\pi^0) = (0.22 \pm 0.04)$ mbn. Momentum and angular parameters of $\pi^\pm$ mesons in c.m.s. are obtained. (auth)

Particle Interactions and Properties (Theoretical)

General

42888 (LA-tr-70-15) PHASE-SPACE VOLUME OF ANGULAR CORRELATIONS FOR REACTIONS OF THE TYPE A + B → C + D + E FOR THE CASE OF ARBITRARY PARTICLE MASSES. Suslenko, V. K. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by Helen Dahlby (Los Alamos Scientific Lab., N. Mex.), from report JINR-P2-4914. 4p. Dep. CFSTI.

This item was previously abstracted from the original language and appeared in NSA as 24: 21945.

42889 (NYO-2171-310) THEORETICAL AND EXPERIMENTAL RESEARCH ACTIVITIES IN HIGH ENERGY PHYSICS, Progress Report, September 1968–May 1970. (Pennsylvania Univ., Philadelphia. Dept. of Physics). Contract AT(30-1)-2171. 61p. Dep. CFSTI.

Research in high-energy physics at the University of Pennsylvania during the period from September 1968 to May 1970 is reported. The theoretical research covers elementary particle physics and nuclear structure, while the experimental research includes weak and strong interactions. The supporting facilities are also described. A list of articles published during this period is included. (J.F.P.)

42890 (NYO-3399-226) RESEARCH PROGRAM IN ELEMENTARY PARTICLE THEORY. Progress Report for the Period Ending August 31, 1970. (Syracuse Univ., N. Y. Dept. of Physics). Contract AT(30-1)-3399. 31p. (SU-1206-226). Dep. CFSTI.

Research on elementary particle theory for the period ending August 31, 1970 at Syracuse University is reported. This research covers dual models, local duality, phenomenology based on Regge poles and cuts, deep inelastic scattering, two-variable expansion of scattering amplitudes and constraints on partial waves, chiral symmetry, and unified description of weak and electromagnetic interactions. A list of publications is included. (J.F.P.)

42891 (ORO-3992-17) RESEARCH PROGRAM IN ELEMENTARY PARTICLE THEORY. Progress Report. Sudarshan, E. C. G. (Texas Univ., Austin. Dept. of Physics). [1969]. Contract AT(40-1)-3992. 24p. Dep. CFSTI.

A summary of research on elementary particle theory is presented. This research covers tachyon theory, scattering of shadow states, duality and the Veneziano amplitude, and Regge theory and Lorentz poles. Also current algebra and chiral symmetry, field theory, and weak and electromagnetic interactions are covered. (J.F.P.)

42892 (UCRL-19780) DUAL RESONANCE MODELS FOR VECTOR CURRENTS. Weis, J. H. (California Univ., Berkeley. Lawrence Radiation Lab.). 6 May 1970. Contract W-7405-eng-48. 75p. (CONF-700806-27). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

Recent work on dual Reggeized resonance models for vector currents is discussed. The properties vector current amplitudes in such models are expected to possess are first described in some detail; i.e., (i) factorization, (ii) divergence conditions, and (iii) good large-q^2 behavior. Presently existing models fall into two classes: factorizable models that emphasize (i) and (ii) at the expense of (iii), and phenomenological models that emphasize (ii) at the expense of (i) and (iii). These models are discussed and a new phenomenological model is proposed that incorporates exponentially falling form factors, a property it is believed dual resonance models should possess. The partial successes described is found a source of optimism for an eventual complete solution of the problem. (auth)

42893 LECTURES ON PARTICLES AND FIELDS. Aly, H. H. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970). 381p. $24.50.

Separate abstracts were prepared for each of the 12 lectures. (J.F.P.)

For abstracts of individual lectures see: 42909, 42930, 42931, 42935, 42936, 42954, 42970, 43004, 43017, 43018, 43061, and 43062.

42894 THREE STEPS IN THE STRUCTURE OF MATTER. Weisskopf, Victor F. (Massachusetts Inst. of Tech., Cambridge). Phys. Today; 23: No. 8, 17-22; 24(Aug 1970).

The structure of atoms and nuclei are reviewed in order to compare with this the structure of elementary particles. The relation of atoms with molecules is compared with that of elementary particles with nuclei. Mathematical expressions of particle structure are also mentioned. (J.F.P.)

42895 NONCAUSALITY AND INSTABILITY IN ULTRADENSE MATTER. Bludman, S. A. (Univ. of Pennsylvania, Philadelphia); Ruderman, M. A. Phys. Rev., D; 1: 3243-6(15 Jun 1970).

In a classical system of particles interacting via neutral vector-meson exchange, at very high densities the pressure exceeds the relativistic energy density, and the speed of low-frequency sound waves exceeds the speed of light in vacuum. A quantum version of the same model, if it is stable against spontaneous pair production, can be neither ultrabaric nor superluminal, if, at high density, the correlation energy increases faster than the number of particles. Real matter, if it is stable at very high densities, is not expected to show noncausal sound propagation. (auth)

42896 MEROMORPHIC DUAL AMPLITUDE FOR TWO-FERMION–THREE-BOSON SCATTERING. Lebrun, J. P. (Cambridge Univ., Eng.). Lett. Nuovo Cim.; 3: 819-23(27 Jun 1970).

The problem is solved of how to find a suitable infinite sequence of Veneziano satellite terms that generate the correct residues on the poles in all planar channels while maintaining strict duality, meromorphy, maximal crossing invariance compatible with the symmetry of the problem and Regge behavior with fixed fermion J-plane cuts. A previous formula is rederived for N = 4, and it is shown how to construct crossing-symmetric amplitudes with different powers of the mass in the two channels. Thus an amplitude with three active channels is possible. The method is illustrated by giving a strictly dual crossing-symmetric expression for N = 5. (J.F.P.)

Electromagnetic

Refer also to abstracts 42865 and 43001.

42897 (COO-264-553) η-3π DECAY WITH SUSSKIND'S MODEL. Miyatake, Yoshio (Chicago Univ., Ill. Enrico Fermi

Inst.). Jul 1970. Contract AT(11-1)-264. 17p. (EFI-70-40). Dep. CFSTI.

The $\eta \rightarrow \pi^+ + \pi^- + \pi^0$ decay amplitude is calculated with Susskind's formula. The result is not good if all multiperipheral tree-diagrams are taken, although some of them show very good agreement with experiment. Charge symmetry is satisfied. An interpretation is given to Susskind's formula by analogy with the two-fluid model in superconductivity. (auth)

42898 (DESY-70/23) DIFFRACTION-DISSOCIATION MODEL FOR HIGH-ENERGY RHO-PHOTOPRODUCTION. Kramer, G. (Hamburg Univ. (West Germany). Institut fuer Theoretische Physik (II)); Quinn, H. R. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1970. 51p. Dep. CFSTI (U. S. Sales Only).

A model for two-pion photoproduction in the ρ-resonance region is constructed. The production proceeds by diffraction dissociation of a photon into a pion pair which interacts strongly in the p-wave state. The effects of initial and final absorptive interaction with the proton are also included. Particular attention is paid to the invariant-mass spectrum of the dipion system. (auth)

42899 (SU-1206-225) EFFECT OF A TRANSVERSE MOMENTUM DISTRIBUTION IN THE PARTON MODEL. Gardiner, C. W.; Majumdar, D. P. (Syracuse Univ., N. Y. Dept. of Physics). Apr 1970. 31p. (NYO-3399-225). Dep. CFSTI.

The parton model for the inelastic lepton-nucleon scattering is generalized to include a realistic momentum distribution of the partons. In this formalism each parton is given a component of momentum which is orthogonal in a four-vector sense to the nucleon momentum. An approximation scheme is developed to take into account the effect of this orthogonal (transverse) momentum distribution of the partons. It is found to generate an additional scale invariant contribution to the structure function $\nu W_2(\nu, Q^2)$ as well as a nonscale-invariant contribution, as is expected. The scale invariance breaking term is found to be a power series in Q^2/ν^2 and vanishes as ν or Q^2 goes to infinity for a fixed $\omega = 2M\nu/Q^2$. The effect of the transverse momentum distribution is explicitly displayed and discussed for a few momentum distribution functions. The data on inelastic e-p scattering are then analyzed for any significant deviations from scale invariance, and it is concluded that there is evidence for such deviations. On the assumption that the systematic errors in the data are small, some fits are made which display the dependence on Q^2. Finally an attempt is made to fit the data with the formalism developed. For this purpose use is made of a model for the partons, proposed previously to explain the data in the approximation that scale invariance is satisfied. Some comments are made on the properties of partons which are necessary to fit the data and on the present status of scale invariance breaking. (auth)

42900 REGGE POLE MODEL AND ANOMALOUS MAGNETIC MOMENTS OF NEUTRAL HYPERONS. Iwao, Syurei (Kanazawa Univ., Japan). Progr. Theor. Phys. (Kyoto); 43: 242-4(Jan 1970).

It is pointed out that experimental studies of $\gamma p \rightarrow \Lambda K^+$ and $\gamma p \rightarrow \Sigma^* K^+$ interactions at backward angles are important for the determination of the anomalous magnetic moments of neutral hyperons and for testing the validity of particular Regge pole exchanges. (L.B.S.)

42901 EFFECT OF WEAK INTERACTION ON ELECTROMAGNETIC INTERACTION. Fukuda, Reijiro (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: 149-61(Jan 1970).

A renormalizable weak interaction mediated by the weak boson with additional component, which has a negative metric, is investigated. The general argument on the renormalization of the electromagnetic vertex in the parity violating case is presented and, using this argument, a possibility of finite self-mass and self-charge of the electron and the muon by the use of the ξ-limiting Lagrangian of Lee and Yang is discussed. In this way the mass of the usual weak boson is found to be $242m_p$ and that of the additional boson with a negative metric $140m_p$, which is the same value as that proposed by Terazawa, where m_p is the proton mass. Finally the effect of the weak interaction on the Lamb-shift and the polarization of the final electron in the scattering plane are calculated up to the lowest order of the weak interaction. Both effects are extremely small owing to the largeness of the weak boson mass and therefore negligible. (auth)

42902 NUCLEON ELECTROMAGNETIC FORM FACTORS AT HIGH MOMENTUM TRANSFERS IN AN EXTENDED PARTICLE MODEL BASED ON THE QUARK MODEL. Fujimura, Kimio; Kobayashi, Tsunehiro; Namiki, Mikio (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 43: 73-9(Jan 1970).

Taking account of the Lorentz contraction effect of the extended nucleon core as a nucleon but not as a quark, it is shown that the Gaussian inner orbital wave function can produce the form factor very close to the dipole formula. (auth)

42903 REGGE POLE MODEL WITH THE DIFFRACTIVE CORRECTION. III. DIFFRACTIVE REGGE POLE MODEL AND CONSPIRACY RELATION. Biyajima, Minoru (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 43: 61-72(Jan 1970).

Explanation of the π^+-photoproduction and the pn-charge exchange scattering by the Regge pole model with the diffractive corrections was previously given. However, relations between the diffractive Regge pole model and conspiracy conditions were not discussed. Thus it is shown that conspirator requirements of the invariant amplitudes at $t = 0$ are satisfied by the unitary correction term due to pion pole and diffractive scattering. It is found that the correction term satisfies the requirements of class III of conspiracy without introducing π_c. Further investigation of $\pi N \rightarrow \rho N$ scattering leads to the conclusion that the class II and class III of conspiracy conditions are satisfied by the unitary correction terms. (auth)

42904 ENERGY DEPENDENCE OF PARTIAL CROSS SECTIONS FOR MULTIPION PHOTOPRODUCTION. Brandt, S. (Univ., Heidelberg). Phys. Lett.; 32B: 388-90(3 Aug 1970).

The energy dependence of the cross section for multiple pion production by photons is found in agreement with the simple power law suggested by Hofmokl and Wroblewski for inelastic hadron-hadron collisions. Fits of available data to this law are presented. (auth)

42905 MASS DEPENDENCE OF MOMENTUM TRANSFER DISTRIBUTIONS IN DIFFRACTION DISSOCIATION. Satz, H. (CERN, Geneva). Phys. Lett.; 32B: 380-2(3 Aug 1970).

Peripheral diffraction dissociation mechanisms together with diffractive resonance production are investigated and predictions for structure in the mass dependence of the inelastic diffraction slope are obtained. (auth)

42906 IMPLICATIONS OF INELASTIC ELECTRON SCATTERING DATA FOR VECTOR MESON DOMINANCE. Nauenberg, M. (CERN, Geneva). Phys. Lett.; 32B: 383-4(3 Aug 1970).

An analysis of the recent high energy inelastic electron proton scattering data cast doubts on the validity of successful vector meson dominance relations for photoproduction. (auth)

42907 CHARGE DISTRIBUTION OF THE PION. Narita, Takao (Tohoku Gakuin Univ., Japan). Progr. Theor. Phys. (Kyoto); 43: 567-8(Feb 1970).

The charge distribution of the pion is examined by using the assumption that the nucleon charge and the magnetic moment form factors have the same isotopic structure, and the assumption of the universal couplings of ρ to nucleons and pions. (L.B.S.)

42908 HARARI'S CONJECTURE AND PHOTOPRODUCTION OF φ MESON. Okada, Kunihiko (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 43: 566-7(Feb 1970).

Harari provided the conjecture for finite energy sum rule that the Pomeranchuk trajectory is mostly built by the nonresonating background in the low energy amplitude, while the ordinary trajectories can usually be described in terms of the resonance approximation for the low energy region. This conjecture is tested by photoproduction of ϕ mesons under the vector meson dominance hypothesis. It is concluded that Harari's conjecture predicts the constancy of $\sigma(\gamma p \rightarrow \varphi p)$ over a wide range of energy and the gradual decrease of $\sigma(\gamma p \rightarrow \rho^0 p)$ and $\sigma(\gamma p \rightarrow \omega p)$ at high energies, and that the predictions seem to be supported by experiment. (L.B.S.)

42909 COMPOSITE STRUCTURE OF LEPTONS AND THE EXISTENCE OF THE μ-MESON. Barut, A. O. (Univ. of Colorado, Boulder). pp 341-5 of Lectures on Particles and Fields. /Aly, H. H. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

A solution to the electron-muon puzzle is proposed. For this, one of the standard assumptions in the Dirac theory of the electron that of the proportionality between the conserved quantum mechanical matter current and the conserved electromagnetic current is no longer assumed. That is, it is assumed that the distribution of the leptonic matter and the distribution of the electric charge is not the same. (J.F.P.)

42910 CURRENT ALGEBRAS AND UNIVERSAL DIVERGENT RADIATIVE CORRECTIONS. Gaffney, G. W. (Stanford Univ., Calif.). Ann. Phys. (N. Y.); 58: 335-87(Jun 1970).

Using current algebras, the ultraviolet divergences occurring in the calculation of electromagnetic radiative corrections to any

lowest order weak process are examined at arbitrary momentum transfer. All orders in perturbation theory are considered in the fine structure constant α. The divergent parts of the radiative corrections are expressed in terms of matrix elements of equal-time current commutators by using the Bjorken expansion of time-ordered products of currents at large momenta. The validity of this expansion and of the use of "naive" current commutation relations is assumed in discussing various current algebra models. The condition is imposed that the divergences contribute only to an unobservable, universal weak coupling constant renormalization. It is shown that, in models with operator Schwinger terms in the current commutators, this condition cannot be satisfied for nonzero momentum transfer. Also, it is not satisfied for a weak interaction theory mediated by a vector boson. Two current algebra models are exhibited which are satisfactory if the weak Hamiltonian has a local current–current form. For these models, the weak and electromagnetic currents of both the hadrons and the leptons obey the same commutation relations, and the Schwinger terms are c numbers. One, a quark model of hadrons with integrally charged quarks together with the conventional lepton currents, gives finite radiative corrections. The second, the algebra of fields model for the total electromagnetic and weak currents, including leptons, contains only a universal divergent factor. These two results are shown to hold to all orders in α. In obtaining these results, divergent contributions to electromagnetic mass shifts and to electromagnetic renormalization effects in strong interaction processes are isolated and removed by adding a counter term to the interaction Hamiltonian. These divergences may thus be treated as a separate problem, which is not discussed in detail. (auth)

42911 VACUUM POLARIZATION CORRECTIONS AND e^+–e^- ANNIHILATION. Gatto, R. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Lett. Nuovo Cim.; 4: 117-19(18 Jul 1970).

The implications of the equations for the amplitude of $e^+ + e^-$ annihilation including vacuum polarization corrections are studied. Two cases are distinguished. One is the case in which the vector resonance couples to the particular final state only through virtual photons; and the other case is that in which the vector resonance decays into the final state by strong interactions. (J.F.P.)

42912 SUPERSELECTION RULE FOR CHARGE. Wick, G.-C. (Columbia Univ., New York); Wightman, A. S.; Wigner, Eugene P. Phys. Rev., D; 1: 3267-9(15 Jun 1970).

The customary notion of superselection rule stipulates the vanishing of those matrix elements of the density matrix that connect states separated by the superselection rule, i.e., the relative phases of which are, according to the superselection rule, meaningless. It is shown that, if any two states for which an additive conserved quantity has different values are separated for all physical systems by a superselection rule at one time, the separation will persist for all times. It is concluded that the states with different electric (or baryonic) charges are so separated. The reason for the difference between electric charge and other additive conserved quantities, such as momentum, is brought out. (auth)

42913 SIMULTANEOUS DETERMINATION OF TWO PARAMETERS IN THE $^1S_0$ WAVE NEUTRON–NEUTRON INTERACTION. Slobodrian, R. J. (Univ., Laval, Can.); Meiner, H.; Ernst, J.; McKee, J. S. C.; Conzett, H. E.; Bacher, A. D.; Resmini, F. G. pp 160 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).

See CONF-690804.

42914 VECTOR-MESON DOMINANCE AND PION PHOTOPRODUCTION. Potter, W. T.; Sullivan, J. D. (Univ. of Illinois, Urbana). Nuovo Cim.; 68A: 623-56(21 Aug 1970).

The vector-dominance model applied to single-pion photoproduction is considered. Dispersion relations are written for a set of invariant amplitudes. Particular attention is paid to the problems of gauge invariance and kinematic singularities. At high energies the results coincide, to leading order only, with the use of s-channel helicity amplitudes. It is argued that the use of the Donohue-Högaasen frame is meaningless. Finally the ambiguity in the choice of best extrapolation path is discussed. (auth)

42915 PHOTOPRODUCTION OF NEUTRAL VECTOR MESONS ON LIGHT NUCLEI. Akhiezer, A. I.; Rekalo, M. P. (Physical-Technical Inst., Kharkov). Yadern. Fiz.; 11: 1298-1304(Jun 1970). (In Russian).

Coherent photoproduction of neutral vector mesons on nuclei ^{2}H, ^{3}H, and ^{3}He is considered on basis of the Regge pole model and the quark model. The observed ratio of the ρ-meson photoproduction cross sections on deuterons and protons may be explained only in the Regge-pole model. The models considered predict for the ratio of the ω-meson photoproduction cross sections on nuclei ^{2}H, ^{3}H, and ^{3}He to the cross section on protons certain values that are essentially less than those obtained with assumption of pure diffractional ω-meson production. (auth)

42916 EXPERIMENTAL TEST OF COULOMB'S LAW. Bartlett, D. F.; Goldhagen, P. E.; Phillips, E. A. (Princeton Univ., N. J.). Contract AT(30-1)-2137. Phys. Rev., D; 2: 483-7(1 Aug 1970).

One of the classic "null experiments" tests the exactness of the electrostatic inverse-square law. The outer shell of a spherical capacitor is raised to a potential V with respect to a distant ground, and the potential difference ΔV induced between the inner and outer shells is measured. If this induced potential difference is not zero, Coulomb's law is violated. For example, if it is assumed that the force between charges varies as r^{-2+q}, then $\Delta V/V$ is approximately a tenth of q. In the experiment five concentric spheres are used. A potential difference of 40 kV at 2500 Hz is impressed between the outer two spheres. A lock-in detector with a sensitivity of about 0.2 nV measures the potential difference between the inner two spheres. It is found that $|q| \leq 1.3 \times 10^{-13}$. Comparable limits are also found on the detected signal when the operating frequency is 250 Hz, and when the detector is synchronized with the charging current rather than with the charge itself. (auth)

42917 CURRENT COMMUTATORS AND THE 2^+ NONET IN ELECTROPRODUCTION AND NEUTRINO-INDUCED PRODUCTION. Cornwall, John M. (Univ. of California, Los Angeles). Phys. Rev., D; 2: 578-83(1 Aug 1970).

Commutators of the type $[\dot{J}_1, J_1]$, where J_μ is a vector or an axial-vector current, are expressed in terms of canonical 2^+ meson fields. (More generally, a commutator involving the nth time derivative is expressed in terms of fields of spin n + 1.) One consequence is that electromagnetic mass differences are finite. Predictions are made for electroproduction and neutrino-induced production; where comparisons are possible, the agreement with experiment is excellent. (auth)

42918 ANOMALOUS WARD IDENTITIES, HARD-MESON CALCULATIONS, AND THE $\pi^0\gamma\gamma$ FORM FACTOR. Young, Binglin (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 2: 606-13(1 Aug 1970).

Assuming the anomalous axial-vector Ward identity for the $\langle VVA\rangle$ three-point functions, the $\rho-\omega-\pi$ and $\rho-\varphi-\pi$ vertex functions and the off-mass-shell $\pi^0\gamma\gamma$ form factor is calculated in the framework of Schnitzer and Weinberg's hard-meson calculations. The mass-shell value of the form factor reduces to a result of Adler; and its off-mass-shell values are used to predict certain electron-positron annihilation cross sections. The results of the present model are compared with those of the conventional vector-meson-dominance model. (auth)

42919 NUMERICAL STUDY OF REGGE CUTS DUE TO ABSORPTION IN NEUTRAL-PION PHOTOPRODUCTION. Miller, R. A. (Univ. of Illinois, Urbana). Phys. Rev., D; 2: 598-605(1 Aug 1970).

The relationship between Regge cuts and absorption is reviewed. A detailed numerical study is carried through for the Gottfried–Jackson absorption model as applied to the reaction $\gamma p \to \pi^0 p$ with Reggeized ω exchange. The absorption parameters are set from πp elastic scattering data. Calculations of s- and t-channel amplitudes and cut discontinuities are presented and discussed as regards their advantages and shortcomings for fitting the neutral-pion photoproduction data. Several published fits are compared. It is concluded that the cut contribution must be roughly doubled to obtain a successful fit. (auth)

42920 COVARIANCE OF RETARDED COMMUTATORS. Rothe, Klaus D. (Univ., Heidelberg). Z. Phys.; 236: 430-9 (1970).

The Lorentz structure of the retarded commutators relevant to the electroproduction of pions and the weak radiative decay of hyperons is investigated within the framework of the Jost–Lehmann–Dyson representation, assuming a given asymptotic behavior for the spectral functions. In particular the connection between the covariance of these retarded commutators and the absence of Schwinger terms in the corresponding equal time commutators is studied. (auth)

Weak

Refer also to abstract 42864.

42921 (UJV-2432-F) ON THE FULL EXPERIMENT IN WEAK SEMILEPTONIC HYPERON DECAYS. Dittrich, J.; Janouch, F. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1970. 12p. Dep. CFSTI (U. S. Sales Only).

An attempt is made to determine a set (or sets) of experiments which represents a full experiment for weak and semileptonic hyperon decays, assuming local current-current V-A Lagrangian. The discussion covers the main theoretical assumptions, the formulas, different variants for full experiments, and the procedure used for the determination of the unknown parameters. (J.F.P.)

42922 (UJV-2435-F) MODEL OF LEPTONS. Hosek, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1970. 5p. Dep. CFSTI.

A new scheme of the weak leptonic interactions is presented in which the leptons interact via neutral spin-1 mesons. (auth)

42923 INVESTIGATION OF NONLEPTONIC HYPERON DECAYS AND BARYON β-DECAYS BASED ON THE QUARTET MODEL. Murayama, Akihiro (Kyoto Univ. Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto); 43: 125-43(Jan 1970).

The correspondence between the phenomenological laws for nonleptonic hyperon decays and the quartet model is investigated. It is shown that the S-wave decays can be explained by the single-urbaryon transition with the derivative type coupling, while the P-wave decays can be explained by the two-urbaryon transition. The quartet model is applied further to the baryon β-decays and it succeeds in describing the G_A/G_V-ratio of the neutron β-decay and the F/D-ratio of the axial-vector coupling in a compatible way with the nonleptonic hyperon decays. (auth)

42924 NONPERTURBATION APPROACH TO DECAY PROBLEMS. Yamamoto, Kunio (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 43: 162-71(Jan 1970).

A non-perturbation approach to decay problems is presented. The results may be applicable to strong interaction decays provided that the width is sufficiently small. For weak interaction decays, including that of the neutral kaon, all the results are identical with those of perturbation theory. As a limit of the case with two unstable states with different masses, lifetimes and decay modes, the unstable state associated with double pole is considered. Before taking the limit two unstable states are needed; after taking the limit the double pole unstable states does not have a partner. Some discussion is given of the difference between the resonances (decay through strong interaction) and the unstable particles (decay through weak interaction). (auth)

42925 MESON DECAYS IN THE DYNAMICAL COMPOSITE MODEL. Fukushima, Kunio (Nagoya Univ., Japan); Kaiba, Masayuki; Kudo, Kiyoshi. Progr. Theor. Phys. (Kyoto); 43: 172-83(Jan 1970).

The various three-meson-vertices $M \rightarrow M' + M''$ are examined on the basis of the dynamical composite model in which it is assumed that the mesons M and M′ are dynamical composite systems of urbaryon and anti-urbaryon and one of the final meson, M″, is structureless. It should be noted that the transition matrix elements of the $M \rightarrow M' + M''$ decay processes contain only one parameter in addition to the urbaryon mass. By comparing them with the experimental decay widths, the reasonable value of the urbaryon mass is determined ($2 \sim 10$ GeV) for the processes $0^+ \rightarrow 0^- + 0^-$, $1^- \rightarrow 0^- + 0^-$, $1^- \rightarrow 1^- + 0^-$ and $2^+ \rightarrow 0^- + 0^-$, but the value is not reconciled with the processes $1^+ \rightarrow 0^+ + 0^-$, $1^+ \rightarrow 1^- + 0^-$ and $2^+ \rightarrow 1^- + 0^-$. (auth)

42926 TWO-PHOTON ASSOCIATED DECAYS OF K MESON. Iwao, Syurei (Kanazawa Univ., Japan). Progr. Theor. Phys. (Kyoto); 43: 144-8(Jan 1970).

Current commutation relations and partially conserved axial-vector current hypothesis (PCAC) are applied to the two-photon associated decays of K meson. On the assumption that the effective weak interactions should have the transformation properties discussed by Suzuki in connection with the hadronic decays of kaon, and that the axial-vector isospin charges to which the pions are related through PCAC should be generators of $U(2) \times U(2)$. In the approximation of neglecting the continuation, the decay rates of $K_1^0 \rightarrow \gamma\gamma$ and $K^+ \rightarrow \pi^+\gamma\gamma$ are calculated as a function of the scalar and the pseudoscalar amplitudes, and the pion energy spectrum for the latter decay is obtained. (auth)

42927 DIRAC MATRIX GROUP AND FIERZ TRANSFORMATIONS. de Vries, E.; van Zanten, A. J. (Univ., Groningen, Netherlands). Commun. Math. Phys.; 17: 322-42(1970).

The representation theory of the group generated by the Dirac matrices is studied. It is shown that the Fierz transformation can be expressed in terms of Racah coefficients of this group. A number of generalized Fierz transformations are found. Simple rules are given for calculating Fierz invariants and anti-invariants. (auth)

42928 NUCLEAR COULOMB EFFECTS ON THE INDUCED PSEUDOSCALAR INTERACTION IN THE THEORY OF MUON CAPTURE BY NUCLEI. Baba, Kazuo (Nara Women's Univ., Japan). Progr. Theor. Phys. (Kyoto); 43: 390-406(Feb 1970).

Variations of the strength of the induced pseudoscalar coupling C_P in muon capture by nuclei due to nuclear Coulomb effects on both pion propagator and muon wave function are calculated by assuming point nuclei with the effective charge $Z_{eff}e$. Those Coulomb effects depend not only on Z_{eff} but also on the energy of the neutrino emitted in the process in consideration. In the low-energy region of the neutrino the Coulomb effects on both quantities are nearly cancelled out by each other, while in the high-energy region (corresponding to the case of normal muon capture) a considerable net effect remains and C_P is reduced by several percent ($5 \sim 9\%$ for $Z_{eff} = 7.47 \sim 16.17$, i.e., for $Z = 8 \sim 20$) compared with its magnitude when no Coulomb effects are taken into account. (auth)

42929 FORWARD PRODUCTION CROSS SECTIONS FOR BARYONS AND BARYON RESONANCES BY NEUTRINO. Iwata, Takashi; Takemura, Tadao; Kobayashi, Tsunehiro (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 43: 552-4(Feb 1970).

The forward production cross sections for baryons and baryon resonances by neutrinos are evaluated in the quark model. Numerical results are tabulated for $E_\gamma = 3$ GeV. (L.B.S.)

42930 WEAK INTERACTIONS IN THE NUCLEAR SHADOW. Bell, J. S. (CERN, Geneva). pp 323-40 of Lectures on Particles and Fields. /Aly, H. H. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

The presentation of weak interactions in the nuclear shadow includes the optical model for virtual mesons, nuclear absorption, the eikonal approximation, application to photoproduction of vector mesons, coupled propagation, and neutrino reactions. (J.F.P.)

42931 PHENOMENOLOGY OF K_{l3} DECAY. Ryan, C. (University Coll., Dublin). pp 347-74 of Lectures on Particles and Fields. /Aly, H. H. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

A general phenomenological treatment of three-body semileptonic decays of kaons is given emphasizing generality. A discussion is given of the basic experimental facts, kinematics, general form of the matrix elements and the restrictions imposed on it by various symmetries and the local action of leptons. The general decay-polarization distribution and the various special distributions which can be obtained from it are deduced. Finally, a comparison between theory and experiment, and form factors in V-A theory are discussed. (J.F.P.)

42932 RADIATIVE β DECAYS OF HYPERONS. Kaganskii, A. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz.; 11: 1272-7(Jun 1970). (In Russian).

Expressions for the probability of radiative β decay of hyperons are obtained taking into account two first terms of the amplitude expansion in powers of the photon momentum. Unlike nonleptonic decays, the contribution from magnetic moments of baryons to the probability is nonzero even in this order. The contribution from the amplitudes of direct transitions is discussed. (auth)

42933 MUON INELASTICITY IN UNDERGROUND COSMIC-RAY NEUTRINO INTERACTIONS. Bjorken, J. D. (Stanford Univ., Calif.). Nuovo Cim.; 68A: 567-71(21 Aug 1970).

The inelasticity of the secondary muon in high-energy neutrino interactions, defined in a manner appropriate for the deep-mine cosmic-ray experiments, is computed. On the basis of the hypothesis of locality of the lepton current, $\langle E_\mu/E_\nu \rangle = 0.62 \pm 0.12$. (auth)

Strong (General)

42934 HARMONIC OSCILLATOR IN MODERN PHYSICS: FROM ATOMS TO QUARKS. Moshinsky, M. Documents on Modern Physics. New York; Gordon and Breach, Science Publishers, Inc. (1969). 97p. $10.00.

The theoretical structure of many-particle harmonic-oscillator states and the range of their applications in atomic, molecular, nuclear, and quark physics are shown. The one-, two-, three-, and four-body problems are treated, and the n-body problem in the Hartree-Fock approximation is discussed. (J.F.P.)

42935 STRONG INTERACTION SUM RULES: AN INTRODUCTION TO RECENT DEVELOPMENTS. Costa, G. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua); Shaw, Graham. pp 27-57 of Lectures on Particles and Fields. /Aly,

H. H. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

In this review of strong-interaction sum rules an account of the types of approaches used is given and illustrated by a few simple examples. The types of sum rules used, low and high-energy phenomenology, duality and bootstraps, and spectral-function sum rules are covered. (J.F.P.)

42936 PHENOMENOLOGICAL HADRON COUPLINGS. Mitra, A. N. (Univ. of Delhi). pp 125-211 of Lectures on Particles and Fields. /Aly, H. H. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

An outline of the theory and application of a semi-quantitative phenomenological model of hadron couplings is given with special reference to the decay widths of various resonances. Coupling among L = 0 hadrons, symmetry classification of hadron resonances, couplings between different supermultiplets, phenomenological analysis of hadron decays with L ≠ 0, an improved relativistic model of hadron couplings, and a comparison of improved model with experiment are treated. (J.F.P.)

42937 REDUCTION OF THE HWA EQUATION AND LINEAR TRAJECTORIES. Matsumoto, Yasuo (Kyoto Univ). Progr. Theor. Phys. (Kyoto); 43: 499-509(Feb 1970).

Hwa's method of reducing the relativistic spin wave equation is generalized. It is found that the representations of the homogeneous Lorentz group for which the generators of this group together with a vector operator constitute a closed algebra are the Dirac, the Duffin–Kemmer and the Majorana representations only. An infinite-dimensional wave equation is constructed which gives a linearly rising Regge trajectory. By reducing this equation, the direct product of the Majorana and the Dirac representations are obtained. (auth)

42938 MULTIPLICITY, PIONIZATION, AND THE HYPOTHESIS OF LIMITING FRAGMENTATION IN HIGH-ENERGY COLLISIONS. Hsu, J. P. (McGill Univ., Montreal). Lett. Nuovo Cim.; 3: 793-5(20 Jun 1970).

Various inconsistencies in interpretation of the hypothesis of limiting fragmentation in extra-high-energy collisions are pointed out. It is shown that an electron colliding with hadrons at high energy is very likely to break up into fragments. The possible existence of pionization at extra-high-energy collisions in the BCYY framework is also suggested. (L.B.S.)

42939 RESONANCES IN DECAY AND PRODUCTION PROCESSES AND THE VENEZIANO MODEL. Bialas, A. (Jagellonian Univ., Krakow. Inst. of Nuclear Physics, Krakow); Turnau, J.; Zalewski, K. Lett. Nuovo Cim.; 4: 326-8(22 Aug 1970).

The expansion of the production and decay amplitudes into final-state resonances is considered. It is shown that in the Veneziano model it is impossible to satisfy simultaneously certain conditions for decay and production amplitudes. It is found that the resonances as seen in production processes have in general different characteristics than the same resonances seen in formation processes. (J.F.P.)

42940 $\rho(\omega)$-EXCHANGE AMPLITUDE, DUALITY, AND COMPLEX CONJUGATE PAIR OF REGGE POLES. Minami, S. (Osaka City Univ.). Lett. Nuovo Cim.; 4: 333-6(22 Aug 1970).

An additional factor is introduced in the expression of the spin-nonflip amplitude due to the $\rho(\omega)$ trajectory with odd signature. This factor modifies theoretical predictions for certain reactions. Using such modified predictions, the difference between the conventional Regge pole model and the complex conjugate Regge pole pair model is examined. Proton interactions with various hadrons are discussed. (J.F.P.)

42941 COMMENTS ON HADRON MASS DEPENDENCE IN QUARK MODELS. Goodman, L. (Drexel Univ., Philadelphia). Nuovo Cim.; 68A: 605-11(21 Aug 1970).

A modified harmonic-oscillator potential provides dynamics consistent with known empirical information in the nonrelativistic quark model. The composite mass depends linearly on the constituent mass for deviations about the constituent mass in the Dirac quark model. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 43012.

42942 (COO-264-552) OPERATORIAL CONSTRUCTION OF MULTIPLE CHARGED PION AMPLITUDES. Willemsen, Jorge F. (Chicago Univ., Ill.). Jul 1970. Contract AT(11-1)-264. 22p. (EFI-70-39). Dep. CFSTI.

It is shown that taking the "chiral symmetry" result $\alpha\rho(0)-\alpha\pi(0)=\frac{1}{2}$ as a hypothesis allows straightforward use of the oscillator formalism to construct 4π and 6π amplitudes with no tachyon ghosts, and full Regge behavior. An attempt is made to isolate which features of such schemes to generalize the Lovelace amplitude lead to problematic results in the multipion amplitudes which are obtained. (auth)

42943 (COO-264-554) NO-GO THEOREMS FOR DUAL MODELS. Balachandran, A. P. (Syracuse Univ., N. Y. Dept. of Physics. Tata Inst. of Fundamental, Bombay (India)); Chang, L. N.; Frampton, P. H. (Chicago Univ., Ill. Enrico Fermi Inst.). Jul 1970. Contract AT(11-1)-264. 14p. (EFI-70-41). Dep. CFSTI.

Two no-go theorems relevant to the construction of positive-intercept dual models are stated and proved. The theorems explain why one cannot develop a physically sensible model by a simple multiplicative modification of the usual (negative-intercept) N particle dual amplitude. (auth)

42944 (NYO-3399-222) MULTIVARIABLE EXPANSION OF THE SCATTERING AMPLITUDE INVOLVING AN ARBITRARY NUMBER OF SPINLESS PARTICLES AND CROSSING SYMMETRY FOR PARTIAL WAVES. Modjtehedzadeh, M. (Syracuse Univ., N. Y. Dept. of Physics). Feb 1970. 45p. (SU-1206-222). Dep. CFSTI.

An infinite number of sum rules for the scattering processes involving any finite number of spinless particles is derived. Each sum rule involves a finite number of partial wave amplitudes from direct and crossed channels. These sum rules are implied by the crossing symmetry of the system and are complete. These sum rules are classified into an independent set, hence a basis for multivariable expansion is obtained. This basis displays the threshold and pseudothreshold zeroes and kinematic singularities of the partial waves. (auth)

42945 (UCRL-19826) CENTRIFUGAL BARRIER EFFECTS IN MESON DECAYS. Quigg, C.; von Hippel, F. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1970. Contract W-7405-eng-48. 15p. (CONF-700525-6). Dep. CFSTI.

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa.

Centrifugal barrier penetration factors are used to investigate the kinematics of meson decays in order to probe hadron spectroscopy. All dynamical effects are neglected. An attempt is made to provide a framework in which the dynamics may be isolated and studied experimentally. (J.F.P.)

42946 RISING REGGE TRAJECTORIES AND FINITE ENERGY SUM RULES. Fujisaki, Haruo (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: 101-13(Jan 1970).

It is shown in the narrow-resonance approximation that in order to satisfy the finite energy sum rules (FESR), all Regge trajectories except for the Pomeranchukon must be accompanied by an infinite number of daughter trajectories, which are asymptotically parallel to the leading ones. In the presence of an infinite number of daughter trajectories, the narrow-resonance saturation of the FESR cannot give effective constraints on the asymptotic energy-dependence of the trajectory functions, without aid of additional assumptions on the Regge parameters. (auth)

42947 DUALITY AND S-WAVE PION–PION SCATTERING LENGTHS IN THE VENEZIANO MODEL. Takagi, Fujio (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 43: 91-100 (Jan 1970).

The characteristic feature of the duality contained in the Veneziano model is investigated by expanding the Veneziano-type amplitude into an infinite sum of pole terms in a particular channel. It is shown that the forward dispersion relations hold for the Veneziano-type amplitude and that there is a consistent correspondence between the convergence of a dispersion integral and that of an infinite sum of pole terms. S-wave pion-pion scattering lengths are analyzed in terms of both the crossed channel pole exchange and the forward dispersion relations. It is investigated why a discrepancy of a factor $2/\pi$ has occurred between the Reggeized Kawarabayashi–Suzuki–Riazuddin–Fayyazuddin relation and the ordinary one. It is found that there is a strong one-to-one correspondence (a kind of strong local duality) between the contributions to the t-channel isospin-one combination of the scattering lengths from the direct (s- and u-) channel poles (through the forward dispersion relation) and the contributions from the t-channel pole exchanges. A discussion is given on the definition of duality. (auth)

42948 NON-ZERO MASS GAUGE CONDITION AND THE VENEZIANO MODEL. Itabashi, Kiyomi (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 43: 114-24(Jan 1970).

It is shown that there exists a certain condition for the normal-parity part of the P + V reaction amplitudes, where P and V stand for the pseudoscalar and vector mesons, respectively. This condition (the non-zero mass gauge condition) comes from the helicity constraint and is an analog of the gauge condition for the real photon reaction amplitudes. The argument is extended to any reaction that involves spin-0 and spin-1 mesons (of arbitrary parities) as external particles, e.g., V + baryon → baryon + P. The non-zero mass gauge condition has practical importance especially in the Veneziano model. Discussions in connection with this model are also presented. (auth)

42949 QUARKS AND DOUBLE-PEAKED A_2 MESON. Chylek, Petr (Univ. of California, Riverside). Progr. Theor. Phys. (Kyoto); 43: 233-5(Jan 1970).

It is shown that under some restrictive assumptions the two-peaked A_2 structure can lead to the $(q\bar{q})^3$ composition for mesons. (L.B.S.)

42950 NEW DUALITY EFFECTS IN MANY PION SYSTEMS. Rubinstein, H. R. (Weizmann Inst. of Science, Rehovot, Israel). Contract F-61052-68-C-0070. Phys. Lett.; 32B: 370-4(3 Aug 1970).

As a consequence of duality and absence of exotic states two-body distributions in many pion systems are shown to have peaks that appear and disappear as a function of the number of external neutral pions. Agreement with experiment is excellent. (auth)

42951 ASYMPTOTIC CONDITION OF SCATTERING THEORY. Amrein, W. O.; Martin, Ph. A.; Misra, B. (Univ., Geneva). Helv. Phys. Acta; 43: 313-44(1 Jul 1970).

A new formulation of the asymptotic condition of scattering theory is proposed which applies to Coulomb interactions and other long-range potentials and which generalizes the usual asymptotic condition. It consists of the requirement that the constants of the free motion be asymptotically stationary also under the real evolution. From this and two supplementary conditions the existence of wave operators and of a scattering operator is proven. It is then shown that the wave operators are strong operator limits as in standard scattering theory except that the free evolution may have to be replaced by a modified propagator. Finally, Dollard's method of proving the asymptotic convergence for the Coulomb interaction is extended to a more general class of potentials. (auth)

42952 GAMMA DECAY OF MESONS IN THE BARYON–ANTIBARYON MODEL. Davidson, M. G. (Western Washington State Coll., Bellingham). Ann. Phys. (N. Y.); 52: 192-207(Mar 1969).

A baryon–antibaryon model for gamma decay of bosons is developed. The problem is factored into charge-space and configuration-space parts and transition matrix elements are calculated in both spaces. The model is applied to transitions between $^1S_0$, $^3S_1$, $^1P_1$, $^3P_0$, $^3P_1$ and $^3P_2$ bosons and compared with experiment. (auth)

42953 BOOTSTRAP ON TWO-TERM VENEZIANO MODEL WITH UNITARITY. Harun-Ar Rashid, A. M. (International Centre for Theoretical Physics, Trieste, Italy). Progr. Theor. Phys. (Kyoto); 43: 478-84(Feb 1970).

The two-term Veneziano amplitude for pion-pion scattering is investigated to determine its effect on the Yellin–Shapiro inequality for the intercept of the rho-meson trajectory. Then, following the proposal of Igi and Storrow, the model is combined with unitarity and a sum rule of Arbab and Slansky is made to yield the residue parameters which are found to be in reasonable agreement with previous determinations. (auth)

42954 SOME APPLICATIONS OF SPECTRAL FUNCTION SUM RULES. Acharya, R. (Univ. of Bern). pp 83-93 of Lectures on Particles and Fields. /Aly, H. H. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

The discussion covers the mass of the kappa meson from spectral function sum rules, a model of spin-zero spectral functions, and the A_1 width from Weinberg sum rules. (J.F.P.)

42955 CONSISTENCY CONDITIONS FOR CROSSING-SYMMETRIC AMPLITUDE WITH DUALITY. Nakazawa, K. (Dalhousie Univ., Halifax, Nova Scotia). Lett. Nuovo Cim.; 3: 799-802(20 Jun 1970).

The consistency conditions for the crossing-symmetric Regge-behaved amplitude with a linearly rising trajectory have been given by a set of linear homogeneous equations which correlate the residues at different poles, but are complicated because the equations contain infinite sums. It is shown that by taking duality into account, the infinite sum in these conditions reduces to a finite sum. The amplitude for $\pi\pi \to \pi\omega$ is investigated for definiteness, although the considerations are applicable to general cases. (L.B.S.)

42956 SUM RULES BASED ON KHURI AMPLITUDES AND DEGENERACY OF REGGE TRAJECTORIES. Kawai, Toshiharu (Osaka City Univ.); Saito, Takesi. Progr. Theor. Phys. (Kyoto); 41: 1057-63(Apr 1969).

Sum rules based on Khuri amplitudes are applied to KN and $\pi\pi$ scatterings. Disregarding the Pomeranchuk contribution, according to a presently accepted philosophy of Harari et al., it is shown that P', ω, ρ and R trajectories are degenerate, i.e., $\alpha_{P'}(t) = \alpha_\omega(t) = \alpha_\rho(t) = \alpha_R(t)$ for any t. If the secondary meson trajectories exist, they also should make a quartet of the above type, i.e., $\alpha_{\rho'}(t) = \alpha_{\omega'}(t) = \alpha_{\rho'}(t) = \alpha_{R'}(t)$. These conclusions are obtained even when the Schmid duality does not hold. (auth)

42957 ON THE CONNECTION BETWEEN PCAC AND CURRENT ALGEBRA. Ellis, J. (Cambridge Univ., Eng.). Lett. Nuovo Cim.; 4: 109-12(18 Jul 1970).

Certain assumptions made in a previous proof of a connection between an operator PCAC condition and a chiral commutation relation are justified under conditions general enough to include conventional phenomenological Lagrangians. Also an ambiguity is noted in the sign of a constant appearing in the chiral commutation relation. It is found that the low-energy theorems obtained from chiral Lagrangians follow largely from the algebraic simplicity of their form and the operator PCAC condition. (J.F.P.)

42958 PHOTOPRODUCTION OF BARYON–ANTIBARYON PAIRS ON NUCLEONS AT HIGH ENERGIES. Rekalo, M. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh.; 15: 854-6 (May 1970). (In Russian).

Correlations for the photoproduction cross sections of baryon-antibaryon pairs on nucleons at large γ-quantum energies were developed considering that the diffraction mechanism is the basic mechanism. In all observed reactions $\gamma + N \to \bar{B}B + N$ the formation process $\bar{p}p$ was assumed to have the largest cross section while formation of $\bar{\Lambda}\Lambda$, $\bar{\Xi}$-Ξ^-, and $\bar{\Omega}$-Ω^- was inhibited considerably. (R.V.J.)

42959 ON THE POSSIBLE ELIMINATION OF UNPHYSICAL STATES IN MESON BOOTSTRAP MODELS. Lebrun, J. P.; Venturi, G. (Cambridge Univ., Eng.). Nuovo Cim.; 68A: 691-700(21 Aug 1970).

It is shown that the imposition of Poincaré invariance on the poles in all channels by free-particle equations of motion can yield an $U_6 \otimes U_6 \otimes O_3$ particle spectrum in narrow-resonance dual models characterized by an $U_{6,6}$ spectrum of trajectories and amplitudes that factorize into a spin–internal-symmetry term and an orbital term. It is further shown that one can construct N-meson amplitudes with the correct tree structure that factorize on each tree into $(N-3)$ collinear $U_6 \otimes O_2$ covariant vertices. This involves the introduction of an interpolating mass function; the restrictions on such a function are briefly discussed; some concrete examples are given. (auth)

42960 CROSS-DUALITY MODEL. Taha, M. O. (International Atomic Energy Agency, Trieste, Italy. United Nations Educational Scientific and Cultural Organization, Trieste, Italy). Lett. Nuovo Cim.; 3: 861-3(27 Jun 1970).

A brief presentation of the cross duality model and its novel features is given. The effects of certain assumptions for $\pi\pi$ scattering are also considered. (J.F.P.)

42961 INEQUALITIES ON LEFT-HAND DISCONTINUITIES OF PION–PION PARTIAL-WAVE AMPLITUDES. Grassberger, P. (Univ. of Kabul, Afghanistan). Z. Phys.; 236: 410-16 (1970).

The partial wave crossing relations derived by Balachandran and Nuyts are used to derive inequalities among integrals over left-hand discontinuities of elastic pion-pion scattering, weighted by Jacobi functions of the second kind. The only other input for these inequalities are—besides isospin—positivity and boundedness of the right-hand imaginary parts. It is pointed out that similar inequalities follow directly from recent inequalities of Martin. (auth)

42962 DISPERSIVE SUM-RULE TO π–K SCATTERING. McKisic, J. Michael (Ohio State Univ., Columbus). Contract AT(11-1)-1545. Phys. Rev., D; 2: 531-9(1 Aug 1970).

The dispersive sum-rule method, originally developed by Fubini and Furlan, is applied to π–K elastic scattering. Sum rules are derived for the $I = \frac{1}{2}$ and $I = \frac{3}{2}$ scattering amplitudes, and the isospin-antisymmetric combination of the s-wave scattering lengths is calculated. These expressions contain terms involving the off-mass-shell kappa-kaon-pion coupling constant. By following a procedure introduced by Dashen and Weinstein, and assuming

that the SU(3) × SU(3) symmetry-breaking part of the strong-interaction Hamiltonian transforms according to the (3,3*) + (3*,3) representation of SU(3) × SU(3), the off-shell corrections are evaluated. In the evaluation of the off-shell corrections, expressions are obtained for the postulated κ-meson mass and decay width, consistent with a recent experimental indication. The s-wave scattering lengths are consistent with other current-algebra and phenomenological-Lagrangian calculations, but smaller than those recently reported from calculations based on the leading term Veneziano model. (auth)

42963 PION–PION SCATTERING BELOW 850 MeV. A UNIQUE SOLUTION. Morgan, David (Rutherford Lab., Chilton, Eng.); Shaw, Graham. Phys. Rev., D; 2: 520-8(1 Aug 1970).

Forward dispersion relations are used as the basis of an analysis of the information on pion–pion scattering available up to 850 MeV. These are shown to result in a model-independent relation between the scattering lengths α_0 and α_2, valid for all possible behaviors of δ_1^1 in the ρ-region, and taking the value $a_0/a_2 = -3.2 \pm 1.0$ from recent low-energy work, the values $a_0 = 0.16 \pm 0.04$, $a_2 = -0.05 \pm 0.01$ uniquely result. The ambiguity in δ_1^1 in the ρ region is also studied, by four different methods, and uniquely resolved, allowing a detailed picture of all the phases up to 850 MeV to be given. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 42883, 42905, and 43463.

42964 (RLO–2041-37) PHASE BAND ANALYSIS OF π^+–p SCATTERING AT 2.5 TO 3.0 GeV/c. Bridges, David; Moravcsik, Michael J. (Oregon Univ., Eugene); Yokosawa, Akihiko (Argonne National Lab., Ill.). [1970]. 14p. (CONF-700806–25). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

In a partial wave analysis of high-energy scattering data using the phase-band method, the higher partial waves are treated individually as usual, but the lower partial waves are characterized only collectively. The purpose is to determine the higher partial-wave parameters independently of the details of the lower partial waves, which is expected to be possible when the large number of partial waves bring about a substantial decoupling between the various angular momentum states. The method is applied to π^+–p scattering. The energy, in the absence of adequate data at higher energies, is 2.5 to 3.0 GeV/c, which is far from optimal for the method. Nevertheless, good solutions are found, using considerably fewer parameters than a conventional phase shift analysis would have used for the same number of partial waves. The properties of the solutions are discussed and tests are described which probe the reliability of the method. (auth)

42965 ON THE INTERPRETATION OF PARTIAL WAVE PROJECTION OF REGGE POLE EXCHANGES. Masuda, Naohiko (Louisiana State Univ., Baton Rouge). Progr. Theor. Phys. (Kyoto); 43: 237-9(Jan 1970).

Partial-wave amplitudes obtained from Regge pole exchanges are discussed for π N scattering in P_{11} and D_{13} states. It is shown that although the partial wave amplitudes show the anti-clockwise Argand loops, the corresponding partial wave cross sections have no resonance peak but they decrease monotonically as energy increases except at the unitarity violating low energy region. (L.B.S.)

42966 COMMENTS ON DESCRIPTION OF PION–NUCLEON SCATTERING AT INTERMEDIATE ENERGIES. Masuda, Naohiko (Louisiana State Univ., Baton Rouge). Progr. Theor. Phys. (Kyoto); 43: 239-40(Jan 1970).

It is pointed out that the success of the model recently proposed by Kohsaka et al. (Lett. Nuovo Cim. 1: 408(1969)) to describe πN scattering has nothing to do with the validity of the duality principle and of Schmid's interpretation of Argand diagrams, but that it suggests the applicability of the unitarized interference model in which the complex phase factor from Regge pole exchanges substantially suppresses the contribution of the Breit–Wigner amplitude. (L.B.S.)

42967 RADIALLY EXCITED SU(3)-MULTIPLETS AND BARYON RESONANCE CLASSIFICATION. Kaiba, Masayuki (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 43: 80-9(Jan 1970).

Classification of 23 nucleonic resonances is tried on the basis of the symmetric three-quark model which assumes that three quarks are described by a totally symmetric wave function. The basic assumptions are as follows. (1) Each quark inside the baryon behaves as a harmonic oscillator independently of all other quarks (an independent particle model). (2) One of the three quarks is allowed to be in the excited state, while the other two are in the S state (one-particle excitation assumption). (3) Total wave function for the baryon is, in the zeroth approximation, the product of the spatial wave function and the spin-unitary spin wave function. The mass level of nucleonic resonances except for five resonances can be fitted within 60 MeV. In relation to the result, several concluding remarks are given. (auth)

42968 DOUBLED TRAJECTORIES AND π^-p CHARGE EXCHANGE SCATTERING. Johnson, R. C.; Squires, E. J. (Univ. of Durham, Eng.). Phys. Lett.; 32B: 385-7(3 Aug 1970).

It is suggested that the ρ trajectory is doubled and this doubling is used to explain $\pi^-p \to \pi^0n$ data. (auth)

42969 K^+p PHASE-SHIFT ANALYSIS UP TO 2.5 GeV/c. Ayed, R.; Bareyre, P.; Feltesse, J.; Villet, G. (CEN, Saclay, France). Phys. Lett.; 32B: 404-8(3 Aug 1970).

A K^+p phase-shift analysis was performed with the same methods as used for pion-nucleon scattering. Two kinds of solutions were found, both showing an anticlockwise half circle in P_{13} or S_{11}. Their interpretation does not require the necessary existence of a resonance (Z*). (auth)

42970 PHOTOABSORPTION SUM RULES AND THE NONRELATIVISTIC QUARK MODEL. Barton, G. (Univ. of Sussex, Brighton, Eng.). pp 1-26 of Lectures on Particles and Fields. /Aly, H. H. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

Some implications of new sum rules are illustrated for spin-½, i-spin-½ targets by applying them to nonrelativistic bound states using nuclear physics theory and introducing relativistic corrections only where they are unavoidable. This discussion is applied to the nonrelativistic quark model of the nucleon. (J.F.P.)

42971 THEORY OF LOW ENERGY PION–NUCLEON INTERACTION. S-WAVE SCATTERING. Sato, Shigeo (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 43: 453-62(Feb 1970).

The method of constructing a covariant Hamiltonian by making use of Galilei limit is applied to investigate the low energy pion-nucleon interaction. As a consequence, a static Hamiltonian which describes the s-wave pion-nucleon scattering is derived in connection with the well-known p-wave static Hamiltonian. The strength of s-wave coupling is determined by the p-wave coupling constant. To obtain some insight with respect to the relation between the renormalized coupling constants, an approximate but non-perturbational calculation method for the coupling constant renormalization is developed, and the renormalized coupling constants are roughly estimated as functions of the cutoff momentum. Finally, the s-wave pion-nucleon scattering lengths are calculated for I = ½ and 3/2, by taking care of the relation between renormalized coupling constants and cutoff momentum mentioned above. As a result, using $f_r^2 = 1.0$ for renormalized p-wave coupling constant, $\mu a_1 = 0.210$ and $\mu a_3 = -0.105$ at $\Lambda/\mu = 5.17$ are obtained. (auth)

42972 ON THE CONCEPT OF DUALITY AND πN SCATTERING. Hattori, Toshikiko (Tokushima Univ., Japan); Bando, Masako. Progr. Theor, Phys. (Kyoto); 43: 463-77(Feb 1970).

A modified interference model is presented, which relates the direct channel resonance amplitude with the crossed channel Regge pole amplitude. Analyses are made in πN scattering processes by using this model and then the relation between the resonance amplitude and background (Regge pole) amplitude is discussed in order to clarify the concept of "duality." (auth)

42973 MODIFICATION OF THE VENEZIANO MODEL AND ITS APPLICATION TO πN SCATTERING. Sakai, Sunao (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 43: 485-98 (Feb 1970).

The modified Veneziano Model is proposed for πN scattering by adding the confluent hypergeometric function. The degeneracy of $\alpha_\alpha(s)$, $\alpha_\delta(s)$ and $\alpha_\gamma(s)$ was assumed. Isopin constraints are imposed on the model both below $\alpha_\delta(s) = 3$ and in the Regge asymptotic region. Only the parent trajectory is considered. After determination of the free parameters only from low lying resonance poles, the high energy behavior is investigated. The results are also several times larger than experimental results at high energy. Such difficulties are expected to be remedied by unitarity correction. The Regge residues of the model obey Gell–Mann mechanism except at $\alpha_\rho(t) = 0$ and $\alpha_\alpha(u) = -1$, but at these points, dips are predicted in πN charge exchange scattering and πN backward scattering. The model also contains parity doublet, which is an inherent property of the Veneziano model. (auth)

42974 REMARKS ON THE NEW INTERFERENCE MODEL. Minami, S. (Osaka City Univ.). Lett. Nuovo Cim.; 3: 808-10(20 Jun 1970).

The new interference model based on duality is examined for forward and backward $\pi\rho$ scattering amplitudes. (L.B.S.)

42975 DYNAMICAL IMPLICATION OF THE πN P_{11} DATA. Kinoshita, Kisei (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 41: 1046-56(Apr 1969).

In order to search the dynamics to form the nucleon and the Roper resonance, a three-channel model consisting of πN, σN and the third channel is adopted, where the last channel is not specified explicitly. By adjusting elastic and transition forces, this model is able to reproduce the nucleon mass, the πN coupling constant, the phase shift and inelasticity up to 1440 MeV in C. M. energy fairly well, and the bending of the Argand loop near the top of the circle. In this situation, the pure elastic parts (the decoupled amplitudes) of the πN and the third channels have bound states with nearly the same energy near the πN threshold; the σN channel has a resonance and is weakly coupled to πN, but it causes large inelasticity in the low energy region and the bending of the Argand loop. The dynamical importance of the πN and the other channels of the formation of the nucleon may be nearly equivalent. (auth)

42976 DERIVATIVES OF BARYON TRAJECTORIES AT W = 0. Konisi, Gaku (Kwansei Gakuin Univ., Nishinomiya, Japan); Saito, Takesi. Progr. Theor. Phys. (Kyoto); 41: 1081-9(Apr 1969).

It is shown that an analytic property of Khuri amplitudes for πN scattering gives some restrictions on derivatives of baryon-Regge trajectories at W = 0, W being the c. m. energy of πN scattering. Denoting the parent baryon trajectory by $\alpha_0(W)$ and its daughter trajectories by $\alpha_n(W)$ (n = 1, 2, 3, ...), a formula is obtained, which agrees completely with the mass formula in broken $SL_{2,s}$ derived by Domokos, Domokos and Suranyi. An explicit formula is also obtained for a reduced Regge residue at W = 0, expressed in terms of α and its reduced residue $\tau_0(0)$. (auth)

42977 CURRENT ALGEBRA, POLE DOMINANCE, AND MESON–BARYON INTERACTIONS. Radutskii, G. M.; Tabachenko, A. N. (Tomsk Polytechnic Inst., USSR). Teor. Mat. Fiz.; 3: 353-63(Jun 1970). (In Russian).

The formulation of the "hard pion" method proposed previously is generalized to systems including nucleons and the Δ (1236)-resonance. The effective interaction Lagrangians are constructed which allow one to calculate the amplitudes of different meson-baryon reactions. (auth)

42978 PROTON STRUCTURE AND HYPERFINE SPLITTING IN HYDROGEN ATOM. Zinov'ev, G. M.; Struminskii, B. V.; Faustov, R. N.; Chernyak, V. L. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 1284-97(Jun 1970). (In Russian).

Corrections to the Fermi formula due to the proton structure are calculated. A new and simple deduction of the principal formula and a careful analysis of relative contributions from the separate terms are presented. Some arguments are given that the main contribution to the considered corrections is from the region of low photon masses ($k^2 \ll M_p^2$). The results are in agreement with $\alpha^{-1} = 137.036$. (auth)

42979 NARROW-RESONANCE SATURATION OF CURRENT ALGEBRA SUM RULES AND EVIDENCE FOR THE SINGLET NATURE OF $\Lambda^*(1405)$. Gensini, P.; Soliani, G. (Univ., Lecce, Italy. Istituto Nazionale di Fisica Nucleare, Bari, Italy). Lett. Nuovo Cim.; 4: 329-32(22 Aug 1970).

Inverted sum rules are used to evaluate, from experimental values for the amplitudes at threshold, the coupling constants of baryon resonances to meson–baryon states. Particular attention is given to the $\frac{1}{2}^-$ $\Lambda(1405)$. Partial widths are listed for the decay modes of various resonances, and these are compared with experimental values. (J.F.P.)

42980 NEW PREDICTIONS ON $\pi^- + p \to \rho^0 + n$. Cho, C. F.; Sakurai, J. J. (Univ. of California, Los Angeles. Univ. of Chicago). Phys. Rev., D; 2: 517-19(1 Aug 1970).

Assuming that the off-shell Ball amplitudes for $\pi^- + p \to \rho^0 + n$ not only satisfy the constraints imposed by current conservation but also are smooth in the vector-meson mass, all the amplitudes (including longitudinal) for $\pi^- + p \to \rho^0 + n$ are predicted from single-pion photoproduction. The model has no adjustable parameter, yet the calculated cross sections and density matrix are in reasonable agreement with experiment. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 42872, 43116, 43529, and 43530.

42981 (INR-P-1191) BINDING ENERGY OF A Λ PARTICLE IN NUCLEAR MATTER WITH THE NEW HERNDON–TANG Λ–N POTENTIALS. Dabrowski, J.; Hassan, M. J. M. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 5p. Dep. CFSTI (U.S. Sales Only).

The binding energy of a Λ particle in nuclear matter, $B_\Lambda(\infty)$, was calculated with the new Λ–N potentials of Herndon and Tang. The resulting values of $B_\Lambda(\infty)$ lie between 38.7 and 49.5 MeV. Thus, with the new potentials, the problem of overbinding of a Λ particle in nuclear matter remains essentially unchanged. (auth)

42982 (JINR-P2-5118) SYSTEMATICS OF INELASTIC INTERACTIONS OF HIGH-ENERGY PIONS AND NUCLEONS WITH ATOMIC NUCLEI. Barashenkov, V. S.; Gudima, K. K.; Il'inov, A. S.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 72p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Within the intranuclear cascade model detailed and systematic Monte-Carlo calculations of various characteristics of inelastic interactions of pions and nucleons with atomic nuclei were performed in the energy region from a few dozens of MeV up to several GeV. Special attention was paid to the energy region where the pion production processes are essential. The given calculation data allow one to determine by interpolation the corresponding characteristics for intermediate energies and nuclei. (auth)

42983 (TID–25487) ON THE BINDING ENERGY OF A Λ-PARTICLE IN NUCLEAR MATTER. Ram, B.; Williams, W. (New Mexico State Univ., Las Cruces. Dept. of Physics). [1970]. 18p. Dep. CFSTI.

The results of a complete calculation of the binding energy D of a Λ-particle in nuclear matter in the method of independent-pair approximation, which systematically take into account the second- and third-order Born corrections, are presented. It is found that these corrections are small and that the Born-series converges rapidly. A comparison of results with those obtained in other methods based on the Brueckner theory shows that they are identical. (auth)

42984 $^1S_0$ PHASE SHIFT OF NUCLEON–NUCLEON SCATTERING BY THE NAMBU–SALPETER–BETHE EQUATION. II. Tanaka, Fujio (Nara Technical Coll., Japan). Progr. Theor. Phys. (Kyoto); 43: 53-60(Jan 1970).

The Nambu–Salpeter–Bethe equation (so-called the Bethe–Salpeter equation) is solved numerically for the $^1S_0$ state of nucleon-nucleon scattering. Three types of renormalizable meson-nucleon interactions—pion-, neutral-vector-meson- and scalar-meson-exchange—are assumed with ladder approximation. The negative-energy contributions are neglected. A set of parameters (the exchanged meson masses and the meson-nucleon coupling constants) is obtained which reproduce the experimental values of the low energy scattering parameters (the scattering length and the effective range) and the solutions of the phase-shift analysis of energies 25 ~ 270 MeV. The vector-meson-nucleon coupling constant obtained by our calculation is smaller than that obtained by other formulations—the static coordinate space potential, 3-dimensional momentum-space representation and so on. (auth)

42985 ONE-BOSON-EXCHANGE-TYPE POTENTIAL IN TRIPLET EVEN STATE. Kishi, Yosuke (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 43: 39-52(Jan 1970).

The nucleon-nucleon potential of one-boson-exchange type in the triplet even (^3E) state is proposed, which is determined so as to reproduce the two-nucleon scattering data below 350 MeV as well as the deuteron data. In an earlier paper by Kishi, Sawada and Watari, the hard core radius in ^3E state was larger than those in other states. In this paper the same hard core radius is taken in ^3E state as those in other states. The characteristic feature of the potential is that it has a small hard core radius and a weak tensor force in ^3E state. This potential in ^3E state, together with those in other three states given in the earlier paper by Kishi, Sawada and Watari represents a typical nucleon-nucleon potential of one-boson-exchange type. Using our deuteron wave function, the deuteron form factor was also calculated and compared with experiment. (auth)

42986 SIMPLE s HELICITY STRUCTURE AT THE NUCLEON–NUCLEON VERTEX OF THE POMERON AND MESON EXCHANGES: EXPERIMENTAL EVIDENCE AND CONNECTIONS WITH DUALITY. Odorico, R. (CERN, Geneva); Garcia, A.; Garcia-Canal, C. A. Phys. Lett.; 32B: 375-9(3 Aug 1970).

Experimental evidence in favor of an almost pure s helicity non-flip character at the nucleon-nucleon vertex of the Pomeron, f^0 and ω exchanges is discussed. Further some connections with duality of this phenomenon and the related feature of ρ and A_2 exchanges which present an essentially helicity flip coupling at the NN vertex are discussed. (auth)

42987 HIGH ENERGY, SMALL ANGLE ELASTIC SCATTERING OF STRONGLY INTERACTING COMPOSITE PARTICLES.

Czyz, W. (American Univ., Washington, D. C.); Maximon, L. C. Ann. Phys. (N. Y.); 52: 59-121(Mar 1969).

Starting from a simple-minded formulation of the Glauber model of the high energy multiple scattering of strongly interacting composite particles, several generalizations and limiting expressions are derived for the elastic scattering amplitudes at small scattering angles. An extensive discussion of the many possible applications to nucleon–nucleus, nucleus–nucleus and other composite hadron elastic scattering processes is given. (auth)

42988 INELASTIC PROCESS AND THE ONE-BOSON-EXCHANGE MODEL. III. EFFECTS OF THE FORM FACTORS IN PROTON–PROTON COLLISION AT 1 ~ 2 GeV. Kikugawa, Masayoshi; Watari, Wataro; Yonezawa, Mimoru (Hiroshima Univ. Osaka City Univ.). Progr. Theor. Phys. (Kyoto); 43: 407-24(Feb 1970).

The elastic scattering and one-pion-production process in proton–proton collision at 0.97 GeV are analyzed in terms of the one-boson-exchange model considering the effects of the form factors for baryon–meson interactions. The pion production is assumed to proceed through $\Delta(1236)$ resonance production. The one-π, one-ρ, one-ω and one-scalar-meson exchanges are taken for the elastic proton–proton scattering amplitudes T_A. Similarly, the one-π and one-ρ exchanges are taken for the $\Delta(1236)$-resonance production amplitudes T_B. In order to satisfy the unitarity requirements the K-matrix method is used. The observed energy distribution of recoil neutron in the one-pion-production process as well as the experimental data on elastic proton–proton scattering can be reproduced well by this model. The ρ contribution to T_B is found to be very small. This is quite different from the conclusion of our previous attempt. Using the values of parameters obtained by analyzing the data at 0.97 GeV, experimental data on both the elastic and inelastic processes at 1.4 GeV and 2 GeV are fairly well explained. (auth)

42989 DIFFRACTION DISSOCIATION, FINAL STATE INTERACTION, AND QUASI-ELASTIC TWO-BODY PROCESSES. Kagiyama, Shigenori; Uehara, Masayuki (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 43: 425-43(Feb 1970).

The diffraction dissociation model for the production process $p + p \rightarrow p + (\pi + N)^+$ is examined. The partial wave expansion of the production amplitude is done in the rest frame of the dissociated $\pi + N$ system. The resonant final state interaction is introduced by using the dispersion relation technique, where the resonant states $S_{11}(1710)$, $P_{11}(1470)$, $D_{13}(1520)$, $D_{15}(1690)$ and $F_{15}(1690)$ are taken into account. The final state interaction contains not only the onshell term but also the off-shell term, and the on-shell part of the final state interaction coincides with the term given by Rushbrooke phenomenologically. The effect of the resonant final state interaction makes the 1.4 GeV bump sharper but does not produce the second and third peaks observed in experiments, because of the destructive interference between the nonfinal state interacting amplitudes and the final state interacting amplitudes. The second and third peaks are, therefore, considered to be produced by a mechanism different from the diffraction dissociation process. Direct quasi-elastic two-body processes are investigated for these resonance peaks. (auth)

42990 REGGE POLE EXCHANGE AND THE OSCILLATORY BEHAVIOR IN K^+p SCATTERING. Imachi, Masahiro; Kinoshita, Kisei; Shiga, Kunio; Toyoda, Fumihiko; Uehara, Masayuki (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 43: 444-52 (Feb 1970).

It is shown that the oscillatory behavior of the energy dependence of the total cross section and the backward cross section at 180° in K^+p scattering is explained by the crossed-channel Regge-pole exchange. This behavior is due to the effect that the Regge-pole terms oscillate according to the signature factor since t and/or u vary as s varies at fixed angle. Here the exchange degeneracy of Regge trajectories is expected to be somewhat violated. These are consistent with the absence of resonances in the K^+p channel (exotic channel) but the same argument does not hold for the K^-p channel, where genuine resonances are needed. (auth)

42991 MONTE CARLO CALCULATIONS OF THE LIFETIME OF HEAVY HYPERFRAGMENTS. Singh, Triyug (Jammu Univ., India); Prakash, Y.; Bhalla, K. B.; Lokanathan, S. Nuovo Cim.; 68A: 591-604(21 Aug 1970).

The results of the Monte Carlo calculations of the decays of spallation hyperfragments (mass A ~ 20 to A ~ 90) produced from 1.5 and 3.5 GeV/c K^- interactions for various values of the lifetime are presented. The forward/backward asymmetry of the recoils at the decay point with respect to the hyperfragments is used to infer the lifetime. The results of the Monte Carlo calculations are compared with the experimental data of 235 events. It is estimated that the mean lifetime of such hyperfragments is about $(2 \pm 1) \cdot 10^{-12}$ s. (auth)

42992 ASYMPTOTIC THEORY OF INTERACTIONS BETWEEN HADRONS AND ATOMIC NUCLEI. Kancheli, O. V.; Matinyan, S. G. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz.; 11: 1305-17(Jun 1970). (In Russian).

A Reggeon diagram technique for the high-energy hadron interaction with nuclei is developed. It is shown that while the interaction range becomes more than the nuclear radius, the total cross section is proportional to R^2. (auth)

42993 AZIMUTHAL CORRELATIONS AND FIREBALLS. Azimov, S. A.; Beisembaev, R. U.; Mullladzhanov, E. Zh.; Chudakov, V. M.; Yuldashbaev, T. S. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz.; 11: 1248-54(Jun 1970). (In Russian).

Azimuthal correlations are detected in nuclear interactions at energies of hundreds of GeV. In view of the one-fireball model the reason for the correlations may be in its formation and "rotation." (auth)

Particle Invariance Principles and Symmetries

General

42994 GOLDSTONE THEOREM IN A CURVED SPACETIME. Boerner, G. (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 43: 244-6(Jan 1970).

The nature of the Goldstone theorem in (1 + 4) de Sitter space is investigated. The Goldstone states are found to possess only the acausal symmetric invariant function. (L.B.S.)

42995 SYMMETRY PRINCIPLES IN QUANTUM PHYSICS. Fonda, L.; Ghirardi, G. C. Theoretical Physics, A Series of Monographs. Volume 1. New York; Marcel Dekker, Inc. (1970). 527p. $29.75.

The discussion of symmetry principles in atomic physics covers general considerations on the symmetry problem, geometrical symmetries in ordinary quantum mechanics, a survey of group theory, and internal symmetries in ordinary quantum mechanics. Also covered are the Poincaré group and relativistic equations, symmetries in quantum field theory, and unitary symmetries. (J.F.P.)

42996 THE ASYMPTOTIC FORMS OF THE FANO FUNCTION: THE REPRESENTATION FUNCTIONS AND WIGNER COEFFICIENTS OF SO(4) AND E(3). Holman III, Wayne J. (Univ. of Miami, Coral Gables, Fla.). Ann. Phys. (N. Y.); 52: 176-91(Mar 1969).

The Fano function, or Wigner (9 – j) symbol, which is the Wigner coefficient of SO(4), is shown to have an asymptotic limit in which it approaches the form of the SO(4) representation function. Application of the known symmetries of the (9 – j) symbol to this asymptotic form gives us a set of identities which relate the coupling of SO(3) representation functions of different arguments. The representation functions and Wigner coefficients of E(3) are obtained from the corresponding structures of SO(4) by an Inönü–Wigner contraction. Thus the E(3) Wigner coefficient is also an asymptotic form of the Fano function. Hence an even further asymptotic limit exists in which the E(3) Wigner coefficient approaches the form of an E(3) representation function. (auth)

42997 ALGEBRAIC TREATMENT OF THE H-ATOM AND HARMONIC OSCILLATOR WITH AN EXTRA CUBIC FORCE. Cordero, P. (Univ. of Chile, Santiago de Chile). Lett. Nuovo Cim.; 4: 164-6(25 Jul 1970).

A formal connection between spectrum-generating algebras for the Schroedinger equations with potentials $V_1(r) = r^{-1} + \beta r^{-2}$ and $V_2(r) = r^2 + \beta r^{-2}$ is pointed out. Also the problem of the harmonic oscillator with an extra cubic force is solved. (J.F.P.)

Applications (Electromagnetic and Weak)

Refer also to abstract 42867.

42998 (CALT-68-264) TIME REVERSAL INVARIANCE IN THE ELECTROMAGNETIC INTERACTION. Heusch, Clemens A. (California Inst. of Tech., Pasadena. California Univ., Santa Cruz). [1970]. Contract AT(11-1)-68. 35p. (CONF-700325-1). Dep. CFSTI.

From 5th International Conference on Electromagnetic Interactions, Moriond, France.

Time reversal invariance violation in the electromagnetic interactions of hadrons is considered. The formulation of time reversal and some possible tests of T invariance are considered. Various previous experiments on hadron electromagnetic interactions are discussed. (J.F.P.)

42999 MASS FORMULAE AS A TEST FOR PARTICLE SYMMETRIES. Saavedra, I. (Univ., Chile, Santiago). Lett. Nuovo Cim.; 3: 796-8(20 Jun 1970).

It is pointed out that the Gell-Mann-Okubo mass relation for SU(3) is too easily satisfied to be considered significant as a proof of the validity of the theory. This is emphasized by introducing a mass formula arising from completely different initial physical assumptions that reproduces the GMO results fairly well. (L.B.S.)

43000 SEPARATE CPT AND T VIOLATION CHECKS IN THE $K^0-\bar{K}^0$ COMPLEX. Aharony, A. (Tel Aviv Univ., Ramat Aviv, Israel). Lett. Nuovo Cim.; 3: 791-2(20 Jun 1970).

Experiments that allow a separate measurement of CPT and T violation in the $K^0-\bar{K}^0$ complex are pointed out. (L.B.S.)

43001 ESTIMATE OF THE NEUTRON ELECTRIC-DIPOLE MOMENT. McCliment, E. R. (Univ. of Iowa, Iowa City); Teeters, W. D. Nuovo Cim.; 68A: 657-66(21 Aug 1970).

Utilizing the once-integrated commutation relations and the techniques of current algebra, a relation between the neutron electric-dipole moment and the CP-violating parameter ϵ' is established. This relation can be used to place an upper limit on $|\epsilon'|$. (auth)

Applications (Strong)

43002 (NP-18346) REALIZATION OF CHIRAL SYMMETRY IN THE MESON STATES THROUGH SU(4) x O(3). Note No. 262. Boldrighini, C.; Buccella, F.; Celeghini, E.; Sorace, E.; Triolo, L. (Rome Univ. (Italy). Istituto di Fisica). 6 Apr 1970. 11p. Dep. CFSTI (U. S. Sales Only).

A saturation scheme for the equations $[X_a(h), X_b(h)] = i\epsilon_{abc}T_c$ and $[X_a(h), [X_b(h), m^2]] = (\lambda/3)\delta_{ab}[X_c(h), [X_c(h), m^2]]$ within the lower meson states, which belong to the 15 L = 0, 1 representations of SU(4) ⊗ O(3) is proposed. With the introduction of two mixing parameters one can derive the chiral couplings of these particles in reasonable agreement with experiment. In particular the helicity properties of A_1 and B decays come out correctly. (auth)

43003 CHIRAL SYMMETRY IN THE UNIFIED FERMION THEORY. I. SU(2) x SU(2). Hiida, Kichiro (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: 214-32(Jan 1970).

A chiral SU(2) × SU(2) transformation is introduced in a unified fermion theory in which fundamental particles have spin ½ and all other particles are composed of them. The properties of transformation and of an invariant Lagrangian density under transformation are investigated in detail. (auth)

43004 ASYMPTOTIC SYMMETRY, SUM RULES, AND RENORMALIZATION CONSTANTS. Aly, H. H.; Narayanaswamy, P. (Southern Illinois Univ., Carbondale). pp 59-81 of Lectures on Particles and Fields. /Aly, H. H. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

This review contains asymptotic SU(2) × SU(2) symmetry and its application to πN and ππ scattering sum rules, asymptotic symmetry requirement for the proper amplitudes, and applications of asymptotic symmetry to two-point functions. (J.F.P.)

43005 SOME PROPERTIES OF A HAMILTONIAN MODEL OF BROKEN SU_3 x SU_3 SYMMETRY. Kuo, T. K. (Purdue Univ., Lafayette, Ind.). Lett. Nuovo Cim.; 3: 803-7(20 Jun 1970).

The strong-interaction Hamiltonian density has been written in the explicit form $H = H_0 + H'$, $H' = \alpha(u_8 + \sqrt{r}\,u_0)$, where H_0 is invariant under SU(3) × SU(3). It is shown that if $\tilde{H} = RH'R^{-1}$, where R is any rotation in the SU(3) × SU(3) space, the two theories described by $H = H_0 + H'$ and $\tilde{H} = H_0 + \tilde{H}'$ are equivalent. The question of the uniqueness of the constant r is considered. An explicit R is found such that $\tilde{H}' = \tilde{\alpha}(u_8 + \sqrt{2}\,ru_0)$. The consequences of the nonuniqueness of r is discussed. (L.B.S.)

43006 O(4) SYMMETRY AND RELATIVISTIC COMPOSITE MODEL. Ito, Hitoshi (Kinki Univ., Osaka). Progr. Theor. Phys. (Kyoto); 41: 1109-17(Apr 1969).

The O(4) symmetry of the bound state amplitude of two Dirac particles is explored at zero mass. The states are classified into eight families and some of them are proven to be unphysical. By using this symmetry and the Bethe-Salpeter equation, a relativistic formalism for composite model is proposed in the neighborhood of zero mass. Explicit form of the kernel is given for pion's family in the ladder approximation of pseudo-scalar meson exchange. (auth)

43007 CANCELLATION OF DIVERGENCES AND BROKEN SYMMETRY. Takasu, M. (Meijo Univ., Nagoya, Japan). Lett. Nuovo Cim.; 4: 93-5(18 Jul 1970).

Preliminary results for the calculations of hadron mass differences with divergence cancellation, giving results connecting the structure of the weak current with the symmetry breaking parameters of strong interactions, are given. This calculation differs from the previous ones in that an isosymmetric SU(3) × SU(3)-breaking strong Hamiltonian is assumed and a general neutral V-A current is used. (J.F.P.)

Field Theories

General

43008 EXACT SOLUTIONS OF THE EQUATIONS OF THE CLASSICAL NON-ABELIAN GAUGE FIELD. Kerner, Richard (Univ., Paris). Compt. Rend., Ser. A; 270: 1467-9(1 Jun 1970). (In French).

The existence is demonstrated of a denumerable series for the exact classical solutions of the equations of a non-Abelian gauge field corresponding to a compact and semi-simple gauge group. (auth) (France)

43009 WEAK-FIELD APPROXIMATION IN THE ALREADY UNIFIED THEORY. Lynch, J. T. (Inst. of Tech., Bendigo, Australia). Lett. Nuovo Cim.; 4: 341-5(22 Aug 1970).

From the weak-field approximation to the field equations of the Rainich already unified theory, an electromagnetic field is derived. This field is in general a transverse wave propagating in the y direction. (J.F.P.)

Quantum Field Theory

Refer also to abstracts 42893 and 43063.

43010 (DESY-70/26) SUPERPROPAGATOR OF FIELDS WITH EXPONENTIAL COUPLING. Lehmann, H.; Pohlmeyer, K. (Hamburg Univ. (West Germany). Institut fuer Theoretische Physik (II)). Jun 1970. 12p. Dep. CFSTI (U. S. Sales Only).

The vacuum expectation value of the time-ordered product of two exponentials of free fields is defined as a distribution using minimal singularity as a criterion. The implication of this definition for an exponentially self-coupled scalar field is studied in second-order of a perturbation expansion. (auth)

43011 (NYO-2171-318) SELF-ADJOINT ALGEBRAS OF UNBOUNDED OPERATORS. Powers, Robert T. (Pennsylvania Univ., Philadelphia. Dept. of Physics). Jul 1970. Contract AT(30-1)-2171. 15p. Dep. CFSTI.

Some results concerning self-adjoint algebras of unbounded operators in the Wightman formulation of quantum field theory are presented. It is hoped to present the beginnings of an analysis of *-algebras of unbounded operators. (J.F.P.)

43012 NON-LINEAR LAGRANGIAN OF CHIRAL TYPE. Fukuda, Reijiro (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: 206-13(Jan 1970).

Nonlinear Lagrangian of chiral type without derivative interaction is considered to second order. Proper analytic continuation is necessary in order to satisfy the causality and the usual analytic properties. The unitarity is maintained to second order. The amplitudes grow exponentially at high energy. (auth)

43013 AN ATTEMPT AT A GENERAL THEORY OF THE BETHE-SALPETER EQUATION. Ida, Masakuni (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: 184-205(Jan 1970).

The Bethe-Salpeter equation is investigated under some general assumptions, without using specific approximations. The following assumptions are made: 1) the validity of integral representations for the interaction kernel and eigenfunctions, 2) the permissibility of the Wick transform, 3) the absolute boundedness of the transformed kernel and 4) the kernel to be of Hilbert-Schmidt type. In the rest frame the kernel is found to be a real analytic function of P_4 in a strip region of the complex P_4 plane, where P_4 is the total energy multiplied by i. The eigenvalue problem for the hermitian analytic kernel is discussed. As a consequence, the sign of the norm of bound states represented by eigenfunctions with real eigenvalues for total energies in a real interval, is shown to be determined by three factors. This is a generalization of a result known in the equal-mass ladder models. (auth)

43014 LORENTZ COVARIANCE OF THE $\lambda(\varphi^4)_2$ QUANTUM FIELD THEORY. Cannon, John T. (Massachusetts Inst. of Tech., Cambridge); Jaffe, Arthur M. Contracts AF 44620-67-C-0029; AF 44620-70-C-0030. Commun. Math. Phys.; 17: 261-321(1970).

It is proven that the $\lambda(\varphi^4)_2$ quantum field theory model is Lorentz covariant, and that the corresponding theory of bounded observ-

ables satisfies all the Hagg–Kastler axioms. For each Poincaré transformation $\{a, \Lambda\}$ and each bounded region B of Minkowski space a unitary operator U is constructed which correctly transforms the field bilinear forms: $U\,\varphi(x, t)\,U^* = \varphi(\{a, \Lambda\}(x, t))$, for $(x, t) \in B$. Also the von Neumann algebra N(B) of local observables, consisting of bounded functions of the field operators $\varphi(f) = \int \varphi(x,t)f(x,t)dxdt$, supp $f \subset B$. We define a *-isomorphism $\sigma_{a,\Lambda}$: $N(B) \to N(\{a, \Lambda\} B)$ by setting $\sigma_{a,\Lambda}(A) = UAU^*$. The mapping $\{a, \Lambda\} \to \sigma_{a,\Lambda}$ is a representation of the Poincaré group by *-automorphisms of the normed algebra $\cup_B N(B)$ of local observables. (auth)

43015 BOSON FIELDS WITH BOUNDED INTERACTION DENSITIES. Hoeegh-Krohn, Raphael (Princeton Univ., N. J.). Contract AF 49(638)-1545. Commun. Math. Phys.; 17: 179-93 (1970).

Interaction densities of the form $V(\phi(x))$ are considered where $\phi(x)$ is a scalar boson field and $V(\alpha)$ is a bounded real continuous function. The cut-off interaction is defined $V_{\epsilon,r} = \int_{|x|<r} V(\phi_\epsilon(x))$, where $\phi_\epsilon(x)$ is the momentum cut-off field. It is proven that the scattering operator $S_{\epsilon,r}(V)$ corresponding to the cut-off interaction exists, and the behavior of the scattering operator is studied as well as the Heisenberg picture fields, as the cut-off is removed. (auth)

43016 GUAGE INVARIANCE IN QUANTUM ELECTRODYNAMICS. Brandt, Richard A. (Univ. of Maryland, College Park). Ann. Phys. (N. Y.); 52: 122-75(Mar 1969).

A formulation of quantum electrodynamics based on finite local field equations is employed in order to prove and discuss the gauge invariance of the theory in a meaningful and rigorous way. The Dirac and Maxwell equations have the usual forms except that the current operators $f(x)$ and $j^\mu(x)$ are explicitly expressed as finite local limits of sums of nonlocal field products and suitable subtraction terms. The electric current, for example, involves the terms $A(x)$ and $:A^3(x):$. The field equations are used to derive renormalized Dyson–Schwinger-type integral equations for the renormalized proper part functions Σ, $\Pi^{\mu\nu}$, Λ^μ, and $X^{\alpha\beta\gamma\delta}$ (the four-photon vertex function), etc. Application of the boundary conditions $\Sigma(\hat{p} = m) = \Sigma'(\hat{p} = m) = \Pi(0) = \Pi''(0) = \Lambda(\hat{p} = m, 0) = X(0, 0, 0, 0) = 0$ is shown to completely specify the current operators. It is shown that the theory is gauge invariant in the sense that the divergence conditions $k_\mu\Pi^{\mu\nu}(k) = K_\alpha X^{\alpha\beta\gamma\delta}(k, \ldots) = 0$, etc. and the generalized Ward identities $k_\mu\Lambda^\mu(p,k) = e\Sigma(p - k) - e\Sigma(p)$, etc. are all satisfied in each order or perturbation theory. This is shown to be equivalent to the invariance of the field equations under gauge transformations of the second kind. (auth)

43017 FIELD THEORIES WITH INDEFINITE METRIC. Taylor, J. G. (Queen Mary Coll., London). pp 213-45 of Lectures on Particles and Fields. /Aly, H. H. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

It is considered how a general field theory may be set up in the presence of an indefinite metric when complex energies arise. A set of axioms replacing the usual axioms of quantum field theory is given. Special emphasis is given to the asymptotic condition which is vital in determining the validity of dispersion relations, invariance under the full Lorentz group and under the TCP operation. It is also shown how the general theory may be used to obtain previous results for the Lee model. (J.F.P.)

43018 SINGULAR INTERACTION IN QUANTUM FIELD THEORY. Aly, H. H. (Southern Illinois Univ., Carbondale); Guttinger, W.; Mueller, H. J. W. pp 309-22 of Lectures on Particles and Fields. /Aly, H. H. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

Mathematical techniques for relativistic singular interactions are considered including Lorentz-invariant generalized functions, the generalized Lehmann representation, integral equations, and peratization. Also renormalizable and renormalizable field theories are discussed. (J.F.P.)

43019 CONVERGENT FIELD THEORY WITH COMPLEX MASSES. II. QUANTIZATION AND SCATTERING MATRIX. Yamamoto, Hiroshi (Fukui Univ., Japan). Progr. Theor. Phys. (Kyoto); 43: 520-30(Feb 1970).

The field which yields the propagator proposed in a previous paper is quantized. Various invariant functions are obtained and discussed briefly. The unitary scattering matrix is defined as a transformation in the physical subspace of the Fock space expanded by the state vectors. (auth)

43020 QUANTUM ELECTRODYNAMICS WITH INFINITESIMAL NONLINEAR INTERACTIONS. Yokoyama, Kan-ichi (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 43: 531-51(Feb 1970).

In order to obtain a finite self-mass and charge in quantum electrodynamics, some non-linear interactions, the coupling constants of which depend explicitly on a cutoff parameter in the infinitesimal form, are proposed. The self-mass and charge can really become finite, but their values are not determined uniquely by requirement for convergence alone. There is no theoretical basis for giving such values definitely in the present stage. If, however, electrons and muons are treated simultaneously in the present scheme, it is possible to set up the values in such a way that no shift of mass and charge takes place through interactions in the theory, or that, by a self-consistent method, $\delta m_e = m_e$ and $\delta m_\mu = m_\mu$ with no shift of charge. Connection of the formalism with the usual regulator theory is discussed. (auth)

43021 DIAGONALIZATION METHOD OF A HAMILTONIAN IN SECOND-QUANTIZATION. I. Andriambololona, Raoelina (CNRS, Marseille). Progr. Theor. Phys. (Kyoto); 41: 1064-80 (Apr 1969).

A method to obtain all the operators diagonalizing a given Hamiltonian in second-quantization theory is presented. The importance not only of the dynamical commutation relations but also of the kinematical and mutual commutation relations is pointed out. Different classes of Hamiltonians (with examples), programs, degree of a program, order of calculation are introduced. Finally, the practical utilization of the method is given. (auth)

43022 QUANTUM FIELD THEORY WITH SPACE-LIKE MOMENTUM SPECTRUM. Ecker, G. (Univ. of Vienna). Ann. Phys. (N. Y.); 58: 303-21(Jun 1970).

Recently some attempts have been made towards a possible interpretation of spacelike momenta as faster-than-light particles. After a short review of some of those proposals an alternative way to quantize free fields with space-like momentum spectra is put forward. The suggested theory includes the solution of the problem of negative energies which turn up in any theory with space-like momenta. Special emphasis is laid on a thorough discussion of localizability and its consequences for a sensible particle interpretation. Finally, the question of possible interactions is considered. (auth)

43023 FUNCTIONAL QUANTUM THEORY OF FREE RELATIVISTIC FERMI FIELDS. Stumpf, H. (Univ., Tuebingen, Ger.). Z. Naturforsch.; 25a: 575-86(May 1970).

Functional quantum theory of free Fermi fields is treated for the special case of a free Dirac field. All other cases run on the same pattern. Starting with the Schwinger functionals of the free Dirac field, functional equations and corresponding many particle functionals can be derived. To establish a functional quantum theory, a physical interpretation of the functionals is required. It is provided by a mapping of the physical Hilbert space into an appropriate functional Hilbert space, which is introduced here. Mathematical details, especially the problems connected with anticommuting functional sources, are treated. (auth)

43024 QUASICLASSICAL APPROXIMATION IN QUANTUM FIELD THEORY WITH THE STATIC NUCLEON. Barbashov, B. M.; Pervushin, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 3: 320-5(Jun 1970). (In Russian).

The functional integration technique is used for the solution of the scattering problem in quantum field theory with the static nucleon and charged mesons, under the condition that the constant h/g is small. In the same quasiclassical approximation "disentangling" of the τ-matrices is performed. The solution is represented in the form of a certain main term proportional to the large constant g^2/h plus the corrections to this term with respect to h/g. (auth)

43025 REPRESENTATION OF THE JOST–LEHMANN–DYSON TYPE. Vladimirov, V. S.; Zharinov, V. V. (Inst. of Mathematics, Moscow. Moscow Inst. of Physics and Tech.). Teor. Mat. Fiz.; 3: 305-19(Jun 1970). (In Russian).

The integral representation is obtained for functions, holomorphic in tube domains over arbitrary proper cones C and –C and in a neighborhood of a real n-divided open set C and belonging to algebras H(C) and H(–C). As an application the corresponding Jost–Lehmann–Dyson type representation is derived. (auth)

43026 EIKONAL APPROXIMATION IN QUANTUM FIELD THEORY. Barbashov, B. M.; Kuleshov, S. P.; Matveev, V. A.; Sisakyan, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 3: 342-52(Jun 1970). (In Russian).

The asymptotic behavior of the scattering amplitude at high energies and fixed momentum transfers is investigated in the $L_{int} = g:\Psi^2(x)\varphi(x):$ model by means of the functional integration method in quantum field theory. (auth)

43027 PARADOXICAL BEHAVIOR OF FORCE IN SPECIAL RELATIVITY. Johns, K. A. (University Coll. of South Wales

and Monmouthshire, Cardiff). Lett. Nuovo Cim.; 4: 351-4 (22 Aug 1970).

An explanation of certain apparently anomalous facts regarding forces in special relativity theory is provided. It is shown that by proper use of the quantities involved a satisfactory and self-consistent explanation can be given. (J.F.P.)

43028 S + 1 EQUIVALENT FORMULATIONS OF THE THEORY OF MASSIVE FIELD WITH HALF-INTEGER SPINS S + ½ (S = 0, 1, 2, ...). Cukierda, T. (Univ. of Wroclaw). Lett. Nuovo Cim.; 4: 355-8(22 Aug 1970).

There are presented S + 1 equivalent ways of formulating the free theory of massive particles with half-integer spins S + ½ in terms of spinor–tensors. The general formulation of the theory for arbitrary half-integer spin S + ½ is given. It is explicitly shown that for given S there exist only 2(S + ½) + 1 independent solutions of the field equations. The equivalence of the S + 1 formulations of the theories of free massive particles with spin S + ½ given by the S + 1 fields is also proven. (J.F.P.)

43029 INTERPRETATION OF A CERTAIN ANOMALOUS WARD IDENTITY. Schweda, M. (Technische Hochschule, Vienna). Lett. Nuovo Cim.; 4: 359-63(22 Aug 1970).

A simple model used to study generalized Ward identities and their anomalies appearing in perturbation theoretic calculations is considered. The anomalous term is investigated by the point-splitting technique. In this way a more precise description of such anomalies can be given in terms of tadpole contributions. (J.F.P.)

43030 NONLINEAR REALIZATIONS, THE SUGAWARA MODEL, AND GOLDSTONE BOSONS. Solomon, A. I. (Dublin Inst. for Advanced Studies). Lett. Nuovo Cim.; 4: 337-40(22 Aug 1970).

An intimate connection is shown between models involving only currents and Lagrangian models containing only spinless and massless fields which transform nonlinearly under a given internal symmetry group. (J.F.P.)

43031 EQUAL-TIME SINGULARITIES IN RENORMALIZED QUANTUM FIELD THEORY. Lukierski, J. (CERN, Geneva). Nuovo Cim.; 68A: 667-85(21 Aug 1970).

The notion of equal-time singularity replacing for the commutator of renormalized local field operators the notion of equal-time limit is studied. It is shown that in the Wightman framework the equal-time singularity is described by a finite number of one-dimensional tempered distributions. (auth)

43032 GOLDSTONE THEOREM, PHOTONS AND SOMMERFELD'S FINE-STRUCTURE CONSTANT. van der Merwe, P. du T. (Atomic Energy Board, Pretoria). Nuovo Cim.; 68A: 549-66(21 Aug 1970).

The notion of spontaneous breakdown of isospin symmetry as the origin of the photon is investigated in the framework of the unified field theory of elementary particles on the basis of the Goldstone theorem. The treatment evolves towards a particularity of quantum electrodynamics in the hierarchy of interactions. Progress with regard to the problem of unwanted zerons is also reported. An attempt is made to clarify the physical basis of the successes of the unified theory of elementary particles. (auth)

43033 PROPAGATION RATE OF THE ENERGY AND THE KINETIC ENERGY OF THE PARTICLE IN MOTION. Agrgirovic, Milenko. Tehnika (Belgrade); 24: 221-4(1969). (In Serbo-Croatian).

From the expression of the increase of the energy as a result of the increase of the mass, one obtains the ratio existing between the propagation rate of the energy of the particle in motion and of its relativistic kinetic energy. The comparison of this ratio gives the relation which exists between the relativistic kinetic energy and the classical kinetic energy on the one hand, and the increase of the energy as a result of the mass increase on the other hand. The dependence of the mass increase on the "mass fault" is shown, and a new equation for the mass fault in relation with the energies associated with the propagation rates of the energy is given. Two examples, for the cases of positive and negative mass defect, show the precision of the formulas obtained. (tr-auth)

Gravitation and General Relativity

Refer also to abstracts 42341, 42370, 42494, 42495, and 42844.

43034 TOWARD AN ELEMENTARY THEORY OF PLANCKEONS. Stanyukovich, K. P. Probl. Teor. Gravitatsii Elem. Chastits; No. 2, 40-9(1969). (In Russian).

A theory of static Einstein microuniverses (planckeons) with dimensions 10^{-33} cm and mass 10^{-5} g is constructed. It is shown that the radius of the universe a is equal to the gravitational radius r_g of a particle with mass m_0 forming the given universe. By assuming that this particle is quantized and using the relationship $m_0 = h/ac$, the parameters of the planckeon are obtained. It is shown that external effects may make the planckeon not completely closed; the volume, energy, and ordinary and gravitational radii of the planckeon will change. It is assumed that fluctuations in volume and mass (energy) of a planckeon may be considered as elementary particles. The next approximation will then describe gravitons. It was calculated that less energy (10^{20} ev) is necessary for the disintegration of a planckeon having an internal energy of 10^{27} ev and that this energy in turn is equal to the maximum energy of cosmic rays. (JPRS)

43035 EXACT STATIONARY SOLUTION OF THE EINSTEIN-MAXWELL EQUATIONS. Kramer, D.; Neugebauer, G. (Friedrich-Schiller-Univ., Jena, Ger.). Ann. Phys. (Leipzig); 24: 59-61(Nov 1969). (In German).

With the aid of invariance transformations of the Lagrangian a new exact stationary solution of the Einstein-Maxwell equations referring to the exterior field of a charged and rotating isolated source is obtained. (auth)

43036 METHOD FOR CONSTRUCTION OF STATIONARY EINSTEIN-MAXWELL FIELDS. Neugebauer, G.; Kramer, D. (Friedrich-Schiller-Univ., Jena, Ger.). Ann. Phys. (Leipzig); 24: 62-71(Nov 1969). (In German).

General methods are developed for constructing stationary solutions of the Einstein-Maxwell equations from known Einstein-Maxwell fields or vacuum fields. These methods are based on the investigation of an abstract Riemannian V_4 characteristic of the Einstein-Maxwell equations. The application to Kerr's solution demonstrates the practical use of this procedure. (auth)

43037 NATURE OF THE GENERAL RELATIVISTIC SOLUTION OF THE CHARGED LINE MASS. Safko, John L. (Univ. of South Carolina, Columbia). Ann. Phys. (N. Y.); 58: 322-34 (Jun 1970).

The nature of the solution of a line charge is discussed using the already unified field theory. It is shown that it is impossible to have charge without mass with this symmetry. Approximate solutions valid for either small or large mass per unit length are presented and compared with previous work. It is shown that, if charge is present, beyond some critical distance from the axis a neutral test body is repelled instead of attracted. (auth)

43038 RELATIVITY. Proceedings of the Relativity Conference in the Midwest, Held at Cincinnati, Ohio, June 2-6, 1969. Carmeli, Moshe; Fickler, Stuart I.; Witten, Louis (eds.). New York; Plenum Press (1970). 390p. $20.00. (CONF-690641).

The conference included 17 papers. Separate abstracts were prepared for each paper. (J.F.P.)

For abstracts of individual papers see: 42495, 42496, 42859, 42860, and 43039–43051.

43039 SOLUBLE MODELS OF QUANTUM GRAVITATION. Klauder, John R. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 1-17 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

Three models are described in order to study the quantum theory of gravitation. These models, which are concerned with the positivity restrictions on the metric, are algebraically similar to the gravitational theory but are sufficiently simplified so that constraints do not appear. The single-degree-of-freedom model involving the basic ideas, and the scalar and matrix models for the local affine field theory are considered. (J.F.P.)

43040 QUANTIZATION PROGRAM FOR GENERAL RELATIVITY. Komar, Arthur (Yeshiva Univ., New York). pp 19-29 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

The problem of the construction of a quantum theory of gravitation is attacked by a variety of methods. The fundamental epistemological difficulties are ellucidated and certain novel qualitative features of the sought-for quantum theory are described. (auth)

43041 SANDWICH CONJECTURE. Bergmann, Peter G. (Syracuse Univ., N. Y.). pp 43-53 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

The sandwich conjecture by which it is implied that in a purely gravitational field the internal geometries of two distinct three-dimensional space-like hypersurfaces determine uniquely the geometry of a four-dimensional space–time manifold that is required to obey the Einstein field equations is discussed. A certain formulation of the laws of the gravitational field itself is used in this discussion. First an example of a phase space with constraints and equivalence classes in which the sandwich conjecture holds is constructed. Then the general problem is formulated. (J.F.P.)

43042 POST-NEWTONIAN METHODS AND CONSERVATION LAWS. Chandrasekhar, S. (Univ. of Chicago). pp 81-108 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

The conservation laws in general relativity as expressed in terms of the Landau–Lifshitz complex and their role in the development of the successive post-Newtonian approximations to the equations of general relativity of a perfect fluid are discussed. The known conservation laws of Newtonian hydrodynamics are formulated in a language that the relativistic laws appear as natural generalizations. The same laws are considered in the framework of general relativity. In particular the conserved energy is identified as the difference between the (0,0)-component of the Landau–Lifshitz complex and the conserved rest-mass energy ($= c^2\rho u^0\sqrt{-g}$). The development of the first and the second post-Newtonian approximations to the equations of relativistic hydrodynamics are described and illustrated. And finally in the manner in which one can obtain the equations of the $2\frac{1}{2}$–post-Newtonian approximation is described. In this approximation all terms inclusive of $O(c^{-5})$ beyond the Newtonian are retained; it is in this approximation that terms representing the reaction of the fluid to the emission of gravitational radiation by the system first make their appearance. It is shown how the derived radiation-reaction terms of $O(c^{-5})$ contribute to the dissipation of energy and angular momentum in agreement with the predictions of the linearized theory of gravitational radiation. (auth)

43043 RELATIVISTIC BOLTZMANN THEORY AND THE GRAD METHOD OF MOMENTS. Anderson, James L. (Stevens Inst. of Tech., Hoboken, N. J.). pp 109-24 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

The full Boltzmann equation with a collision term that includes binary collisions is discussed. The topics covered are the relativistic Boltzmann equation, elementary properties, equilibrium distribution, the Grad method, normal solutions and transport equations, and asymptotic forms. (J.F.P.)

43044 LEMMA ON THE EINSTEIN–LIOUVILLE EQUATIONS. Berezdivin, R.; Sachs, R. K. (Univ. of California, Berkeley). pp 125-31 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

The discussion of the Einstein–Liouville equations involves the question to what extent symmetries of matter are related to symmetries of space–time. Solutions of these equations are given in three dimensions. (J.F.P.)

43045 CONTRIBUTION TO THE HISTORY OF EINSTEIN'S GEOMETRY AS A BRANCH OF PHYSICS. Guth, Eugene (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville). pp 161-207 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

The historical development of Einstein's attempt to establish a union between geometry and physics is related in separate episodes. It is found that by distinguishing between the historically accidental and the logically essential elements in the progress of Einstein's ideas on gravity, this account illuminates present problems of gravitation. (J.F.P.)

43046 GRAVITATIONAL RADIATION DAMPING. Burke, William L.; Thorne, Kip S. (California Inst. of Tech., Pasadena). pp 209-28 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

Descriptions are presented of two different analyses in which systems which radiate gravitational waves are damped. The first analysis shows how the back-reaction of gravitational radiation can be incorporated with ease into any slow-motion expansion of general relativity. This analysis reveals that the dominant effects of general-relativistic radiation resistance can be incorporated into the Newtonian theory of gravity by a simple change in the boundary condition on the Newtonian potential at $r = \infty$. The rate of energy loss from a radiating system, as calculated by this analysis, agrees with the power carried in the gravitational waves, as calculated by the Isaacson stress-energy tensor or the Landau–Lifschitz pseudotensor. The second analysis treats the small-amplitude, nonradial pulsations of fully relativistic stellar models, which may be arbitrarily close to their Schwarzschild radii. The slow-motion and weak-field approximations, which are crucial to the first analysis, are not made here. As a consequence, the radiation damping appears at first order in the amplitude of pulsation. This analysis reveals that a neutron star formed by gravitational collapse should emit a burst of gravitational waves with frequencies of $\sim 10^3$ hz, energy $\sim 10^{52}$ ergs, and damping time ~ 1 second. In the slow-motion, weak-field limit, the second analysis reduces to the first. (auth)

43047 NATURE OF THE SCHWARZSCHILD SINGULARITY. Rosen, Nathan (Weizman Inst. of Science, Rehovot, Israel. Technion-Israel Inst. of Tech., Haifa, Israel). pp 229-58 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

The discussion of the Schwarzschild singularity covers the Schwarzschild solution associated with a point-mass source, the motion of light rays near this singularity, and the theory with the point mass replaced by a finite-sized particle. (J.F.P.)

43048 SINGULARITIES. Geroch, Robert (Birkbeck Coll., London). pp 259-91 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

In the discussion of singularities the formulation of a suitable definition of a singular spacetime is considered. The discussion also concerns the distribution of the singular solutions of Einstein equations among all solutions and the classification and description of singularities. (J.F.P.)

43049 ENERGY-MOMENTUM OF RADIATING SYSTEMS. Winicour, J. (Aerospace Research Labs., Wright-Patterson, AFB, Ohio). pp 293-302 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

The null hypersurface treatment of asymptotically flat systems is discussed emphasizing the concept of energy. For sufficiently shear-free fields such as represented by small perturbation from spherical symmetry, the results indicate that a system cannot radiate more energy than it possessed in the beginning. (J.F.P.)

43050 THEORY OF SUPERSPACE. Fischer, Arthur Elliot (Princeton Univ., N. J. Univ. of California, Berkeley). pp 303-57 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

A theory of superspace is introduced. The superspace, or space of all geometries, of a fixed closed (compact without boundary) 3-dimensional manifold M is defined as the orbit space L(M) = [Riem (M)]/[Diff (M)] of the group of diffeomorphisms, Diff (M), acting by "coordinate-transformation" on the space of Riemannian metrics, Riem (M). A geometry is then a point in L(M), i.e., an equivalence class of isometric Riemannian metrics. Superspace, as the space of physically distinguishable states, is the proper configuration space for a dynamical theory of relativity. It is the space in which the momentary geometries of space itself evolve. The first result states that this space is in fact a metric space. Since some Riemannian metrics have nontrivial symmetry groups, the associated symmetric geometries do not have neighborhoods homeomorphic to neighborhoods of geometries which have no (nontrivial) symmetries. Since these symmetric geometries are singular points in superspace, L(M) itself does not have a manifold structure. This Structure Problem is resolved by the Decomposition and Stratification Theorems. Superspace is shown to be partitioned into manifolds of geometries, the strata, such that the geometries of high symmetry are completely contained in the boundary of geometries of lower symmetry. A limit of geometries of the same type must therefore be either of the same symmetry type or more symmetrical. In this way a "generalized" dynamical analysis on superspace is possible. Together, these theorems begin the resolution of the fundamental question of both the classical and quantum theory of gravity; to wit, what is the structure of the domain manifold for the quantum-mechanical

state functional? The implications of a symmetric Riemannian structure on the underlying topology is also considered. A complete determination of all topologies compatible with geometries which exhibit continuous groups of symmetries is made in the super-spacial topology theorem. This theorem also gives the possible groups that can occur as symmetry groups. The strata over these symmetric topologies are examined. The stratum theorem proves that the homogeneous geometries of a given symmetry type are parameterized by a finite-dimensional manifold. The superspacial stratum theorem then applies these results to determine explicitly all finite-dimensional and contractible strata for the topologies on which such symmetric geometries can occur. Lastly it is proven that superspace always has an extension to a proper manifold. (auth)

43051 SPACETIME AS A SHEAF OF GEODESICS IN SUPERSPACE. DeWitt, Bryce S. (Univ. of North Carolina, Chapel Hill). pp 359-74 of Relativity. /Carmeli, Moshe (ed.). New York; Plenum Press (1970).

From Relativity Conference, Cincinnati, Ohio. See CONF-690641.

Some nonrigorous arguments are given which suggest that superspace can be extended in such a way that it becomes a Riemannian manifold, and that a spacetime which satisfies Einstein equations can be regarded as a sheaf of geodesics in this extended manifold. (J.F.P.)

43052 ATTRACTIVE FORCE OF THE GRAVITATIONAL FIELD IN STATIC SPACE TIMES. Mueller zum Hagen, H. (King's Coll., London). Proc. Cambridge Phil. Soc.; 68: 187-98(Jul 1970).

A static metric is considered. A meaningful definition of gravitational force is given and the potential, which is the norm of the Killing vector ξ^a, is studied. For the case that the metric is asymptotically flat, the following is shown: The equipotential surfaces are closed 2-dimensional surfaces S lying in the rest space V^3, which is the hypersurface orthogonal to ξ^a. All the surfaces S enclose matter, and the gravitational force points into S towards the enclosed matter. A test particle starting at S will be pulled into the domain bounded by S and will never leave this domain. (auth) (UK)

43053 ANALYTICITY OF STATIONARY VACUUM SOLUTIONS OF EINSTEIN'S EQUATION. Mueller zum Hagen, H. (King's Coll., London). Proc. Cambridge Phil. Soc.; 68: 199-202(Jul 1970).

It is shown that a stationary C^3 vacuum space-time has an analytic structure with respect to which the metric g_{ab} is an analytic tensor field. (auth) (UK)

43054 VARIATIONAL FORMULATION OF STANDARD GENERAL RELATIVITY WHICH INCLUDES THE FULL BIANCHI IDENTITIES IN CONSEQUENCE OF AN EXTENDED GENERAL INVARIANCE PROPERTY. Davis, William R. (North Carolina State Univ., Raleigh). Ann. Phys. (Leipzig); 22: No. 1-2, 77-85(Nov 1968).

The central properties of the usual variational formulations of Einstein's general theory of relativity are sketched and a more general variational formulation is introduced, which is more appropriate to the geometric foundations of the theory. In particular, this formulation leads to the Bianchi identities in their noncontracted form following in consequence of a general invariance property. This invariance property of the general variational principle relates to transformations (not, in general, coordinate transformations) that contain arbitrary fifth (or third) order tensor "generators." These results can be interpreted as implying that the variational principle introduced here admits an "extended principle of general covariance" (i.e., a covariance principle more general than the usual principle relating to general coordinate covariance). Some of the formal implications of these results as well as their connection with general coordinate covariance are discussed briefly. In particular these results point to the existence of a fundamental transformation theory connecting all of the Riemannian space-times of general relativity. (auth)

43055 ESSENTIAL RELATIVITY: SPECIAL, GENERAL, AND COSMOLOGICAL. Rindler, Wolfgang. New York; Van Nostrand Reinhold Company (1969). 333p. $11.50.

The discussion of essential relativity covers absolute space, Einsteinian kinematics and optics, spacetime and four-vectors, relativistic particle mechanics, relativity and electrodynamics, the basic ideas and formal development of general relativity, and cosmology. (J.F.P.)

Scattering Theory

Refer also to abstracts 43024 and 43026.

43056 (CEA-N-1301) PARTIAL WAVE EXPANSION OF THE DENSITY MATRIX (FOR ANY SPIN). Wojcik, Wojciech (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1970. 29p. Dep. CFSTI (U. S. Sales Only).

The helicity amplitude corresponding to the two body reactions is written. The partial wave expansion is derived for the scattering amplitude and the density matrix element; the Fortran program for calculation of the coefficients is given. (France)

43057 (COO-264-551) LEVEL DEGENERACY OF THE GENERALISED N-PARTICLE DUAL AMPLITUDE WITH SATELLITES. Rivers, R. J. (Chicago Univ., Ill. Enrico Fermi Inst.). Jul 1970. Contract AT(11-1)-264. 16p. (EFI-70-37). Dep. CFSTI.

It is shown that the level degeneracy at $\alpha(s) = n$ for the general N-pt function with satellites is $d_n \sim \exp n^\gamma$ as $n \to \infty$ where $\gamma = 1 - (1/2k + 1)$ $k = 1,2, \ldots$ The form of the single loop constructed from such amplitudes is briefly discussed. (auth)

43058 (JINR-P4-5168) MATHEMATICAL PROBLEMS IN MULTICHANNEL SCATTERING THEORY. Zakhar'ev, B. N.; Shmonin, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 19p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The complexity of the calculations in the multichannel scattering theory makes very important the following problem: to what degree the correspondence between the initial data of the problem and the result can be violated by the effect of numerous sources of errors appearing inevitably when solving the problems. The review of modern notions about the mathematical structure of direct methods, constituting the basis of the multichannel theory approaches, as well as about the nature of the sources of errors and the mechanism of their effect on the results is presented. (auth)

43059 SCATTERING AND BOUND STATES FOR A SINGULAR POTENTIAL. Ferreira, Erasmo (Univ. Catolica, Rio de Janeiro); Sesma, Javier; Torres, Pedro L. Progr. Theor. Phys. (Kyoto); 43: 1-9(Jan 1970).

To understand the origin of the difficulties in the determination of the physical wavefunction for an attractive inverse square potential, a model is studied in which the singularity at the origin is substituted by a repulsive core. The structure of the spectrum of energy levels is discussed in some detail. (auth)

43060 AN EQUATION FOR THE POTENTIAL SCATTERING AMPLITUDE. Babikov, V. V.; Mir-Kasimov, R. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 31B: 415-17(30 Mar 1970).

A nonlinear integral equation for the total scattering amplitude is derived. This equation is an analog of the well-known phase equations for partial scattering amplitudes or phase shifts. It is valid for noncentral potentials as well as for central ones. (auth)

43061 VENEZIANO MODEL FOR MESON SYSTEMS AND ITS CONNECTION WITH THE CHIRAL SYMMETRY. Fayyazuddin; Riazuddin (Univ. of Islamabad, Rawalpindi, Pakistan). pp 95-123 of Lectures on Particles and Fields. /Aly, H. H. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

The relation of the Veneziano model with chiral symmetry is considered in this review. The topics covered are $\pi + \pi$ and $\pi + K$ scattering, symmetry breaking, the A_1 $\rho\pi$ system, and K_{l4} form factors. (J.F.P.)

43062 SINGULAR INTERACTIONS IN NONRELATIVISTIC QUANTUM THEORY. Aly, H. H. (Southern Illinois Univ., Carbondale); Guttinger, W.; Mueller, H. J. W. pp 247-307 of Lectures on Particles and Fields. /Aly, H. H. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

Various properties of singular potentials and their applications are reviewed. Definition of the potential, analytic properties of the solutions and the scattering amplitude, and classes of singular potentials are considered. (J.F.P.)

43063 VENEZIANO MODEL AND PROPERTIME FORMULATION. Miyamoto, Yoneji (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 43: 564-5(Feb 1970).

The N-body Veneziano formula is derived in a way analogous to interaction representation of conventional field theory, and insight is given into the unitarity problem. (L.B.S.)

43064 BRANCH CUT CONTRIBUTIONS TO BACKWARD UNEQUAL-MASS SCATTERING PROCESSES. Obara, Takashi (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 41: 1041-5 (Apr 1969).

The contributions of moving branch point $\alpha_c(u)$ in the l-plane to the backward unequal-mass scattering amplitude are examined. It is shown that Khuri amplitudes $b(u,\nu)$ and $c(u,\nu)$ have cuts starting from $\nu = \alpha_c - k$, Re $\nu > -1/2$. The defect of Regge representation owing to unequal-mass kinematics is remedied by introducing the daughter branch point trajectories $\alpha_c^n(u)$, satisfying $\alpha_c^n(0) = \alpha_c^0(0) - n$, of signature $(-1)^n$. The asymptotic form of cut contributions is $t^{\alpha_c}(\ln t)^{-i-1}$. (auth)

43065 UNEQUAL-MASS CONSPIRACY FOR ARBITRARY SPINS. Nakanishi, Noboru; Seto, Noriaki (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 41: 1094-1108(Apr 1969).

The unequal-mass conspiracy problem for arbitrary spins is investigated in detail. Some general properties of daughters and conspirators, including the reflection symmetry for fermion trajectories, are found. The formulas for the expansion coefficients of the trajectory functions at W = 0 are explicitly found to order W^2, where W denotes the invariant energy; the corresponding quantities of the reduced residue functions are also presented. The results for the trajectory functions are compared with the group-theoretical ones of Domokos and Surányi by identifying the smaller one of the absolute values of channel helicities with the Toller quantum number M. The residues of the leading multiple poles on the Khuri plane are calculated explicitly. (auth)

43066 GENERAL PROPERTIES OF MULTIPARTICLE AMPLITUDE IN DUAL RESONANCE MODELS. Donini, E.; Sciuto, S. (Univ., Turin). Ann. Phys. (N. Y.); 58: 388-416 (Jun 1970).

A symmetrical parametrization is used in order to express the generalized Veneziano amplitude without choosing a privileged (multiperipheral) configuration of contemporary poles. The dependence of the N-point function under permutations of the external particles is discussed and the existence of a quasi-invariance property is shown. A particular nonmultiperipheral configuration is considered and, by studying its factorization properties, a compact expression of the residua is obtained, where Wardlike identities are automatically taken into account and the extra-degeneracy of the levels disappears. (auth)

43067 GLAUBER THEORY WITHOUT THE EIKONAL APPROXIMATION. Osborn, T. A. (Oxford Univ.). Ann. Phys. (N. Y.); 58: 417-53(Jun 1970).

The interconnections between the impulse approximation, unitarity, Glauber theory, and the multiple scattering series are examined for high energies. Within the context of scattering from fixed centers, an effective eikonal Hamiltonian is written from which all the two- and three-body scattering results of Glauber may be derived. The unitarity characteristics of Gluber's eikonal solution to multiple scattering and the form of Glauber theory actually used in phenomenological calculations are comparatively discussed. Finally a way of unitarizing the impulse approximation is presented, which obtains all the principal results of Glauber theory but without using the eikonal approximations. This method is constructed to have a natural generalization to scattering from finite mass particles capable of recoil. (auth)

43068 BEST STABILITY IN WEIGHTED DISPERSION RELATIONS. Nenciu, G. Lett. Nuovo Cim.; 4: 96-100 (18 Jul 1970).

Analytic continuation using weighted dispersion relations is discussed. This method is used to study the analyticity of the scattering amplitude. (J.F.P.)

43069 THREE-PARTICLE RELATIVISTIC PROBLEM AND THE GLAUBER TYPE REPRESENTATION. Kvinikhidze, A. N.; Stoyanov, D. Ts. (Tbilisi State Univ., USSR. Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 3: 332-41 (Jun 1970). (In Russian).

The three-dimensional formalism of three-particle relativistic problem on the basis of two-time Green-function is developed. In an approximation which is similar to pair-interaction the kernels of resulting equations are expressed only in terms of quasipotential quantities. A Glauber type formula for relativistic scattering on the bound state is derived. (auth)

43070 DESCRIPTION OF TRIPLE COLLISIONS IN THE THEORY OF STRONG INTER-CHANNEL COUPLING. Amirkhanov, I. V.; Smedarchina, Z. K.; Khristova, E. Kh. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 3: 392-404(Jun 1970). (In Russian).

One of the difficulties in the description of reactions with three free particles at the beginning or the end of the process in the framework of multi-channel formalism is a correct formulation of the boundary conditions. A method of avoiding this trouble is suggested. (auth)

43071 ACCOUNT OF CORE IN THREE-BODY PROBLEM. Simonov, Yu. A.; Badalyan, A. M. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 11: 1318-23(Jun 1970). (In Russian).

The perturbation theory in the core radius is developed for the system of three bodies interacting via a potential with a core. The first order corrections to binding energy and the wave function are explicitly written and contain only one parameter from the core — the scattering length. (auth)

43072 RESOLVENT OPERATOR, PADE APPROXIMATION, AND BOUND STATES IN POTENTIAL SCATTERING. Alabiso, C. (Univ., Parma, Italy. Istituto Nazionale di Fisica Nucleare, Milan); Butera, P.; Prosperi, G. M. Lett. Nuovo Cim.; 3: 831-9(27 Jun 1970).

The Padé approximate technique is applied to the s-wave matrix elements of certain expressions in the case of an exponential $gV = g \exp(-r/a)$. Especially considered are the diagonal elements in the r-representation of the operator R(z) and the diagonal elements in the k-representation of the operator $\overline{T}(z) = VR(z)V$. (J.F.P.)

Particle Accelerators

Refer also to abstracts 43119 and 43313.

43073 (ANL-Trans-846) DAMPING OF COHERENT OSCILLATIONS OF A BEAM IN A STORAGE ELEMENT. II. SYNCHROTRON EXCITATIONS. Derbenev, Ya. S.; Dikanskii, N. S. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated for Argonne National Lab., Ill., from Preprint No. 318. 16p. Dep. CFSTI.

The stability of coherent phase motion of a beam interacting over a chamber segment with ideally matched lines is examined. It is demonstrated that under definite conditions this interaction may lead to so-called memoryless instabilities of synchrotron and radial betatron motion. Damping conditions and expressions for decrements of synchrotron excitations of arbitrary multipole order are derived. (auth)

43074 (CERN-70-20) A PULSED POWER SUPPLY (100 V, 13000 A) FOR SEPTUM MAGNETS. Depping, F. (European Organization for Nuclear Research, Geneva (Switzerland)). 10 Jul 1970. 28p. Dep. CFSTI (U. S. Sales Only).

A pulsed power supply for feeding septum magnets of the CERN proton synchrotron is described. The various aspects for realization during the design stage are shown and their influence on the performance of the supply is discussed. (auth)

43075 (CISE-N-136) PROJECT OF A 8 MeV TANDEM VAN DE GRAAFF. PART II. TERMINAL STABILIZATION. Caruso, E.; Giorgetti, G.; Milazzo, M. (Centro Informazioni Studi Esperienze, Milan (Italy)). Mar 1970. 51p. Dep. CFSTI (U. S. Sales Only).

A terminal voltage stabilization system for an 8 MeV tandem Van de Graaff accelerator is described. The accelerator is equipped with a 90° analyzing magnet which directs the beam through a narrow slit. If the beam energy changes, a signal is obtained from a differential amplifier connected to the slit and used to stabilize the terminal voltage. (W.H.K.)

43076 (IAE-1898) A SYSTEM OF MONOCHROMATIZATION OF THE EXTERNAL BEAM OF THE 2.4-METER ISOCHRONOUS CYCLOTRON OF THE KURCHATOV ATOMIC ENERGY INSTITUTE. Basargin, Yu. G.; Bogdanova, V. I.; Venikov, N. I.; Korol, K. N.; Posel'skii, N. N.; Severgin, Yu. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1969. 20p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The authors adduce the results obtained from designing a system of monochromatization of the external beam of the 2.4-meter cyclotron at Kurchatov, IAE in which use was made of the compensation of the energy dispersal of the beam by a high-frequency debuncher. The separation of the beam according to pulses is accomplished with a special mirror-type symmetrical achromatic magnetic system. The proposal is made to improve the energy dispersal in the beam from ±0.2% to 0.02%. The authors have also examined the methods for the stabilization and smooth variation of energy in this system. (auth)

43077 (IFVE-SEF-69-73) MESON BEAM FOCUSING BY A MAGNETIC HORN. Folomeshkin, V. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1969. 31p. (In Russian). Dep. CFSTI (U. S. Sales Only).

An analysis of various possible constructions for a magnetic horn (MG) is carried out. Definite optimum parameters of MG, the surface shape in the MG most narrow part, and the dependence of the MG optimum shape on the current distance up to the target are defined. The examples of neutrino spectra obtained at using MG are presented. (auth)

43078 (JAERI-1190) 3 MeV 15 kW ELECTRON BEAM GENERATOR AT TAKASAKI RESEARCH ESTABLISHMENT. Oshima, Yunosuke; Yotsumoto, Keiichi; Tanaka, Ryuichi; Tajima, Satoshi; Sunaga, Hiromi (Japan Atomic Energy Research Inst., Takasaki. Takasaki Radiation Chemistry Research Establishment). Jul 1970. 29p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

In 1966 a Cockcroft–Walton type electron accelerator was installed in Takasaki Radiation Chemistry Research Establishment as a second electron accelerator. This accelerator has the maximum output of 3 MV in accelerating voltage and of 5 mA in electron beam current, and continuous rating of 2.5 MV and of 4 mA. The cascade generator circuit of the accelerator is of the symmetrical inverse type using selenium rectifiers operating at a frequency of 10 kHz. The voltage drop and the capacitative input impedance of the generator due to stray capacitance are compensated by coils inserted into the circuit at intervals of 5-stages. The 120-stage accelerating tube is made of overlapped μ-metal electrodes for shielding the external field. The accelerated electron beam is scanned in the width of 60 cm, and emitted into the atmosphere from a scanning window which is made of 200 μm thick aluminum foil. (auth) (Japan)

43079 (JINR-P1-5209) ON THE FEASIBILITY OF POLARIZED PROTON ACCELERATION WITH AN ELECTRON RING ACCELERATOR. Lapidus, L. I.; Plis, Yu. A.; Sarantsev, V. P.; Soroko, L. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 18p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The electron ring accelerator (ERA) may be very useful for the production of polarized particles of high intensity. It is due to the fact that polarized ions are accumulated in the electron ring during the time of injection (approximately 1 msec). With the atomic beam density $\rho = 2 \cdot 10^{10}$ cm^{-3} and the number of electrons in the ring $N_e = 3 \cdot 10^{13}$ we have the number of polarized protons in the ring $N_i = 2.5 \cdot 10^{11}$, i.e., as in the ordinary mode for nonpolarized ions. The crucial problem is to conserve polarization during the time of injection and acceleration. The estimations for P show that the decrease of the number of electrons is necessary for producing polarized ions with a high polarization degree. Fortunately, the limit is rather high ($N_e \leq 3 \cdot 10^{13}$) for the projected parameters of the compressor. The polarized proton beam after acceleration will have the longitudinal polarization, which can be changed to the transversal polarization, if necessary, with the magnet ($l = 2.7$ m, $B = 10^4$ gauss for any energy). The sign of polarization can be changed every pulse that gives possibilities for sensible experiments on the P, T-parity conservation. Some essential experiments are discussed. (auth)

43080 (JINR-P9-5013) CALCULATION OF A TWO-DIMENSIONAL MAGNETIC FIELDS USING IRREGULAR TRIANGULAR COORDINATE LATTICE. Vorozhtsov, S. B.; Zakamskaya, L. T.; Zaplatin, N. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 25p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The method of coordinate lattice is used for calculation of two dimensional magnetic fields for charged particle transport for accelerators. The program for a computer is prepared and the results of calculations are given. The comparison with the experimental data shows the accuracy of calculations to be 1%. (auth)

43081 (NP-18357) ASSUMPTIONS FOR THE COMPARISON OF BENDING AND GRADIENT MAGNET PARAMETERS AND COST. von Schaewen, Juergen (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Dec 1969. 20p. Dep. CFSTI (U. S. Sales Only).

An attempt to get formulas for the cost of accelerator magnet systems is described. Starting from the magnet aperture, the other magnet parameters are calculated. A cost breakdown of the AGS is transposed to this system. The results are tested with prices of the ISR. (auth)

43082 (NP-18358) OPERATION OF THE KARLSRUHE ISOCHRONOUS CYCLOTRON IN 1969. Schatz, G.; Schulz, F. (Kernforschungszentrum, Karlsruhe (West Germany). Zyklotron-Laboratorium). Jun 1970. 9p. Dep. CFSTI (U. S. Sales Only).

Causes of unscheduled shutdown, user statistics, radiation dose at the surface of different machine parts, and total radiation dose received by operating personnel are listed. (W.H.K.)

43083 (ORNL-TM-2834) CALCULATED RESIDUAL RADIATION LEVELS FOR SOME ELEMENTS USED IN CYCLOTRON STRUCTURES. Fulmer, C. B.; Kindred, G. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 28p. Dep. CFSTI.

Residual radiation levels were calculated for beams of protons, deuterons, helium-3, and alpha particles incident on targets of carbon, aluminum, iron, copper, and tantalum. All significant radioactivities were taken into account. Excitation functions, based on experimental data, were used. The calculations are for a range of incident energies and for bombardment times of 8 hours to 1 month and cooling times of 1 hour to 1 week. (auth)

43084 (SLAC-91) TRANSPORT/360: A COMPUTER PROGRAM FOR DESIGNING CHARGED PARTICLE BEAM TRANSPORT SYSTEMS. Brown, Karl L.; Howry, Sam K. (Stanford Linear Accelerator Center, Calif.). Jul 1970. Contract AT-(04-3)-515. 394p. Dep. CFSTI.

TRANSPORT/360, a computer program for the design of static-magnetic beam transport systems based upon a first- and second-order matrix theory of beam transport optics, is presented. Included are: 1) a users manual describing how to prepare data sheets for a TRANSPORT computation; 2) specific examples of simple and complex TRANSPORT computations to illustrate first-order fitting techniques; 3) a set of flow charts; and 4) an appendix containing the underlying optics theory behind the program. (W.H.K.)

43085 (UCRL-19804) STUDY OF A MULTIELEMENT REGENERATIVE EXTRACTION SYSTEM FOR THE BERKELEY 184-INCH CYCLOTRON. Paul, Arthur C. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1970. Contract W-7405-eng-48. 18p. Dep. CFSTI.

This paper discusses the matrix-method calculation of the properties of a three-element regenerative extraction system for a synchrocyclotron. It is shown that the three-element-system stability calculation can be conveniently parametrized in matrix formalism separating the perturbations strengths from the field geometry. Both linear and nonlinear perturbation can be employed with a computer code written to track particle vectors and calculate stability tables from the single-turn matrix for a multielement extraction system. The particle-tracking includes simulation of the effect of acceleration during regeneration. Several extraction systems are considered and comparison is made with the results of numerical integration of the exact equations of motion in the measured magnetic field of the 184-inch cyclotron. (auth)

43086 (UJV-2394-F) CENTERING OF INITIAL ORBITS IN THE CYCLOTRON. Kuzmiak, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1970. 9p. Dep. CFSTI (U. S. Sales Only).

The procedure of calculating the centering of initial cyclotron orbits is described. Initial conditions and the relations involved are given. The investigation relates to the motion in the median plane in an homogeneous electric and magnetic field. (auth)

43087 (UJV-2425-A) SEPARATED TURN ISOCHRONOUS CYCLOTRON WITH NONSINUSOIDAL FORM OF THE RADIO-FREQUENCY FIELD. Kuzmiak, M.; Recman, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1970. 19p. (In Russian). Dep. CFSTI (U. S. Sales Only).

This article deals with the peculiarities of isochronous cyclotron with separated orbits (SOC) and turns (STIC). The process of acceleration by means of non-sinusoidal form of radio-frequency field is described. The conditions for obtaining turn separation are analyzed. The oscillations are not discussed. The investigation concerns the particles moving along the equilibrium paths. (auth)

43088 BIBLIOGRAFIYA PO USKORITELYAM. (Systematical Bibliographies for Accelerators). Grinberg, A. P.; Gusenkova, E. I. Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1970). 404p.

A systematic bibliographic compilation on charged particle accelerators and problems related with the physics and technology of accelerators is presented. The references cover the domestic and foreign publications for the period from 1930 to 1967. Total number of references exceeds 8000. (R.V.J.)

43089 PUMPING OF DEUTERIUM BY TRIODE ION PUMP IN THE 10^{-5} TORR REGION ON A VAN de GRAAFF ACCELERATOR. Baker, L. C. (Hammersmith Hospital, London); Bance, U. R. Vacuum: 20: 251-3(Jun 1970).

After considering the price, operating cost, maintenance cost and the need for freedom from oil vapours in the accelerating tube of the 2MeV Van de Graaff accelerator, the pumping system chosen

was two 300 litre/sec triode ion pumps backed by sorption pumps. The volume of the system, which is unbakeable, is 210 litres. Difficulties were encountered initially in pumping deuterium throughputs due to thermal instability in the ion pumps. By limiting the HT voltage applied to the pumps, the pumping of deuterium was satisfactorily accomplished. (auth) (UK)

43090 INTERACTION BETWEEN DEFECTS IN A CIRCULARLY POLARIZED CYCLOTRON FIELD AND THE MAGNETIC POLARIZATION OF A BEAM OF PROTONS. Besnier, Gilbert (Univ., Rennes, France). Compt. Rend., Ser. B; 270: 1465-8 (8 Jun 1970). (In French).

The resonant depolarization of accelerator beams by oscillating fields have been studied for different configurations of the guide and magnetic fields. The effects of the antiresonant phase occurring with certain rotating fields are described; these fields are generated by azimuthal inhomogeneities in the cyclotron fields. (France)

43091 HISTORICAL DEVELOPMENT OF HIGH-ENERGY ELECTRON THERAPY. Vogel, K.-H. (Univ., Tuebingen, Ger.). Roentgenpraxis; 23: 141-7(Jun 1970). (In German).

The historical development of instrumentation for production of high-energy electron beams is reviewed. Approaches in the USA and in Europe are compared. At present, a 42-MeV betatron is commerically available in Germany which allows rapid conversion from x-ray beam to electron beam. With increased energy, electron therapy is indicated not only for relatively superficial tumors but also for deep seated ones. (40 references) (H.B.G.)

43092 THEORETICAL AND EXPERIMENTAL STUDY OF ION TRANSGAUSSIAN TRAJECTORIES IN A SHIELDED MAGNETIC LENS WITH SYMMETRY OF REVOLUTION. Del'homme, Michel (Laboratoire de Spectrometrie de Masse, Poitiers, France). Rev. Phys. Appl.; 4: 495-500(Dec 1969). (In French).

A method for the determination of transgaussian trajectories of charged particles in a shielded magnetic lens has been proposed in a previous paper; this calculation is obtained, in fact, from magnetic flux measurements and not from field measurements. This method is applied for He^+ ions. The apparatus of investigation of the magnetic flux is described, and also the process using these experimental results for the calculation of the trajectories. An ion optical bench using this lens allowed verification that experimental and computed trajectories are in a good agreement, the difference between computed and measured focal lengths being below 1.5%. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 41532, 41685, and 43183.

43093 (CSIRO-Trans-9991) MINIATURIZED PULSED NEUTRON SOURCE FOR A BOREHOLE GENERATOR. Vasin, V. S.; Galkina, E. B.; Grishaev, A. I. Translated by B. Bergmanis (Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia), from Geofiz. App.; No. 33, 126-9(1967). 10p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article prepared from the original language appeared as NSA 23: 35536.

43094 (WAPD-T-2341) TWO-OVERLAPPING GROUP-TRANSPORT APPROXIMATION FOR THERMAL NEUTRON PROBLEMS. Natelson, M.; Gelbard, E. M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1970. Contract AT-11-1-GEN-14. 19p. (CONF-700608-18). Dep. CFSTI.

From American Nuclear Society Meeting, Los Angeles, Calif.

An approximate method for solving the energy-dependent thermal neutron transport equation in X-Y geometry is given. Two variants of this method have been developed. In the first variant the flux over the whole thermal energy range is treated by the Buslik overlapping group technique. The trial function is of a form first introduced by Lancefield, involving two space-angle functions each multiplied by a trial spectrum. The space-angle functions are computed by solving two coupled transport equations, using S_N or P_N methods. Numerical experiments show that this first approach is not always adequate and that a more complicated, second variant must, sometimes, be used instead. In this second variant the thermal range is split into two bands. The upper band is treated as one neutron group, while the two-overlapping group method is applied in the lower band. Experience indicates that, even when the first method is inadequate, the second is accurate enough for most analysis work. (auth)

43095 TWO-GROUP NEUTRON TRANSPORT THEORY WITH ANISOTROPIC SCATTERING. Thielheim, K. O.; Claussen, K. (Univ., Kiel). Z. Naturforsch.; 25a: 587-94(May 1970).

Two-group transport theory with anisotropic scattering in infinite homogeneous media is presented. The kernel of the integral equation is expanded into a finite series of Legendre polynomials. Eigenfunctions and eigenvalues of the transformed integral equation are found and the number of discrete eigenvalues is calculated. The full-range completeness theorem as well as the orthogonality and normalization relations are presented. As an example the expansion coefficients of the infinite-medium Green's function are explicitly calculated. (auth)

43096 GREEN'S FUNCTION FOR NEUTRON TRANSPORT PROBLEM WITH CYLINDRICAL SYMMETRY. Laletin, N. I. This paper was summarized in At. Energ. (USSR); 26: 370-1 (Apr 1969) as paper No. 274. (In Russian).

Green's function is derived for the problem of the transport of monoenergetic neutrons from a cylindrical source in an infinite homogeneous medium. Green's function is obtained in a form which is convenient to use in the surface pseudosources method and is constructed from elementary solutions having the proper symmetry. The advantages of the method are that elementary solutions are the simplest of all Green's functions in structure; therefore having found a uniform procedure for obtaining different elementary solutions from solutions in plane geometry the problem can be solved in two stages; first solutions for plane geometry are obtained and then elementary solutions are constructed from them in the geometry of the problem under consideration. (auth)

43097 PROPAGATION OF NEUTRON WAVES IN HETEROGENEOUS MEDIA. Stepanov, A. V. This paper was summarized in At. Energ. (USSR); 27: 332(Oct 1969) as paper No. 342/5317. (In Russian).

The passage of neutron waves through a heterogeneous system is considered on the basis of general transport theory for neutrons in nonuniform media. (L.W.A.)

43098 MODERATION OF RESONANCE NEUTRONS IN MATTER. COMMUNICATION I. Kozhevnikov, D. A.; Khavkin, V. S. This paper was summarized in At. Energ. (USSR); 27: 142-3(Aug 1969) as paper No. 329/5166. (In Russian).

An analytic theory is developed that enables one to investigate the physical laws of steady-state and nonstationary moderation of neutrons in matter of arbitrary composition whose scattering and absorption cross sections vary with the neutron energy in accordance with an arbitrary law. (auth)

43099 MODERATION OF RESONANCE NEUTRONS IN MATTER. COMMUNICATION II. Kozhevnikov, D. A.; Khavkin, V. S. This paper was summarized in At. Energ. (USSR); 27: 143-4(Aug 1969) as paper No. 330/5276. (In Russian).

On the basis of the solution of the generalized Weinberg–Wigner–equation steady-state and nonstationary spatially homogeneous problems are considered in the theory of moderation of resonance neutrons in a material of arbitrary composition. (auth)

43100 COLLECTIVE MOTIONS IN CLASSICAL SYSTEMS. III. THEORETICAL INVESTIGATION OF SCATTERING OF THERMAL NEUTRONS BY LIQUID ARGON. Richter, J.; Voss, K. (Technische Univ., Dresden). Ann. Phys. (Leipzig); 23: 49-55(Jun 1969). (In German).

From the Vlasov–Boltzmann model of atomic motion in classical systems the scattering law $S(k,\omega)$ is calculated. The variations of the width of the quasielastic peak are found without using arbitrary additional terms to the convolution approximation. The comparison with the simple BG model shows clearly the influence of the Vlasov term on collective motions. The $S(k,\omega)$ shows the existence of a second Brillouin zone. With this theory experiments can be described, though no parameters are introduced in the calculations. (auth)

43101 REDETERMINATION OF THE COHERENT NEUTRON SCATTERING AMPLITUDE OF RUBIDIUM. Copley, J. R. D. (McMaster Univ., Hamilton, Ont.). Acta Crystallogr., Sect. A; 26: 376-7(1970).

The coherent neutron scattering amplitude of rubidium has been remeasured using powders of RbCl, RbBr, and RbI. A consistent value, $(0.68_5 \pm 0.01) \times 10^{-12}$ cm, was obtained, differing significantly from earlier measurements. The new value is believed to be more reliable. The bound coherent scattering cross section is 5.9 ± 0.2 barns. (auth)

43102 NEUTRON SOURCE-STRENGTH DETERMINATION BY STUDENT LABORATORIES. McGhee, B. W.; Graham III, W. W.; Haroon, M. R. (Georgia Inst. of Tech., Atlanta). Nucl. Appl. Technol.; 8: 531-5(Jun 1970).

The increasing availability of high-strength ^{252}Cf neutron sources for educational use suggests the possibility of a new wave of source-strength measurements in student laboratories. Different methods for calculation and measurement of strengths are discussed. Results obtained by Manganese–Boron Method are compared with the theoretical predictions. Sources of error are pointed out and a procedure is recommended for use in a laboratory. It is concluded that results obtained by this method are accurate to 5% while more elaborate and painstaking measurements may produce about 2% accuracy. (auth)

Nuclear Properties and Reactions, A ≤ 5

43103 EXCITATION OF ^4He BY INELASTIC ELECTRON SCATTERING AT LOW MOMENTUM TRANSFER. Walcher, Th. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett.; 31B: 442-4(30 Mar 1970).

Excitation of the α-particle by inelastic electron scattering is studied at momentum transfers $q < 0.5$ fm^{-1}. The assignment 0^+ for the state at 20.10 ± 0.05 MeV (measured excitation energy) is definitely established. The total width is 270 ± 50 keV, and the monopole matrix element 1.10 ± 0.16 fm^2. Evidence for the M2 resonance at 24 MeV is presented. (auth)

43104 MEASUREMENT OF GROUND STATE QUADRUPOLE MOMENTS USING SIMULTANEOUS COULOMB EXCITATION OF TARGET AND PROJECTILE. Eisenstein, R. A.; Smilansky, U. (Weizman Inst. of Science, Rehovoth, Israel). Phys. Lett.; 31B: 436-8(30 Mar 1970).

The angular distribution of γ rays following simultaneous Coulomb excitation of target and projectile is shown to provide a new method of measuring ground state quadrupole moments. (auth)

43105 USE OF A NUCLEAR REACTOR AS A SOURCE FOR STUDYING THE STRUCTURE OF THE TOTAL CROSS SECTIONS OF FAST NEUTRONS. Kukhtevich, V. I.; Trykov, O. A.; Trykov, L. A.; Goryachev, I. V. This paper was summarized in At.

Energ. (USSR); 27: 141-2(Aug 1969) as paper No. 327/5244. (In Russian).

In order to study the self-shielding of resonances in the total cross section, the transmission spectra are measured for the continuous reactor spectrum; from the transmission spectra, the total cross sections of neutrons are found for water, beryllium oxide, beryllium, iron, stainless steel, chromium, titanium, nickel, and lead. As the detector, a scintillation spectrometer with a stilbene crystal is employed; this device has γ-background discrimination during the deexcitation time. Measurements are performed for initial neutron energies of 0.5 to 17 MeV and different transmission values T; the maximum value of transmission is achieved for iron ($\sim 2.10^{-6}$ for 4 MeV neutrons). (auth)

43106 STUDY OF ^{5}Li AROUND 20 MeV EXCITATION ENERGY BY A RADIATIVE CAPTURE REACTION. Schroeder, H.; Mausberg, W. (Univ., Freiburg i. B.). Z. Phys.; 235: 234-43(1970).

The nucleus ^{5}Li was investigated within an excitation range of 17.8 to 21.1 MeV by measuring γ-rays from the reaction $D(He\text{-}3,\gamma_0)^{5}Li$. In this range, excitation functions and angular distributions were taken. The excitation functions exhibit broad maxima at 20 MeV which indicate, in agreement with other results, a level or a group of levels. Assuming that there is only one resonance, its properties are discussed. On the basis of the existing and the new experimental results, a $J^{\pi} = 1/2^{+}$ assignment is proposed besides the former result $J^{\pi} = (3/2, 5/2)^{+}$. (auth)

43107 REACTION ^{2}H(p,2p)n STUDIED WITH 10.5 MeV POLARIZED PROTONS. Arvieux, J. (Institut des Sciences Nucleaires, Grenoble, France); Durand, J. L.; Faivre, J. C.; Garreta, D.; Papineau, A.; Sura, J.; Tarrats, A. Nucl. Phys.; A150: 75-88(1970).

The asymmetry of the cross section in the complete ^{2}H(p,2p)n experiment induced by 10.5 MeV polarized protons is measured at four sets of angles; one proton is detected at $\theta_1 = 30°$ and the other at $\theta_2 = -30°, -65°, -71°$ and $-75°$. For the set of angles $\theta_1 = 30°$, $\theta_2 = -71°$ and $-75°$, the cross sections exhibit the characteristic peaks corresponding to a minimum correlation energy between a neutron and a proton in the singlet $^{1}S_0$ state. The asymmetry is significantly different from zero and reaches 0.054 ± 0.018 at the n-p pole. At ($\theta_1 = 30°$, $\theta_2 = -65°$) the cross section appears to be double-peaked, which seems to indicate an interference effect. For the measurement at ($\theta_1 = 30°$, $\theta_2 = -30°$) the cross section exhibits a smooth maximum corresponding to a minimum energy of the spectator neutron. The Kuckes–Wilson–Cooper theory gives a peak broader than the experimental one, with an absolute value too high by a factor of approximately two. The corresponding asymmetry is zero within the limits of statistical error. (auth)

43108 COHERENT SMALL-ANGLE SCATTERING OF HIGH-ENERGY PIONS ON LIGHT NUCLEI (^{3}He AND ^{4}He). Baier, Hans (Reaktorzentrum, Seibersdorf, Austria). Z. Naturforsch., 25a: 853-62(Jun 1970). (In German).

The paper discusses recently obtained (theoretical) results on the coherent small-angle elastic scattering of high-energy pions on the nuclei ^{3}He and ^{4}He. Starting with the full suitability parametrized spin- and isospindependent pion-nucleon amplitude for pion laboratory energies between 0.826 and 2.01 GeV the Glauber's plural scattering formula has been applied to derive the angular distribution of scattered pions. A concise report on the use of coherent high energy processes in the investigation of the nuclear structure and the hadron-nucleon scattering amplitude is given. The advantages and shortcomings as well as possible generalizations of the plural scattering model are outlined. The formalism applied to derive results on the structure of ^{3}He and ^{4}He and the conclusions drawn from the results on pion-helium scattering are presented in detail. It has been shown that an effective pion nucleon amplitude may safely replace the full amplitude in the present context and in the energy region mentioned above. (auth)

43109 ELECTRON SCATTERING FROM ^{20}Ne AND He AT 180°. Bendel, W. L. (Naval Research Lab., Washington, D. C.); Chertok, B. T.; Jones, E. C. Jr.; Fagg, L. W. pp 128 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43110 RENORMALIZATION OF BRUECKNER–HARTREE–FOCK THEORY WITH SINGLE-PARTICLE OCCUPATION PROBABILITIES. Beckner, R. L.; Davies, K. T. R. (Oak Ridge National Lab., Tenn.). pp 164 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43111 BRUECKNER–HARTREE–FOCK STUDIES IN LIGHT NUCLEI. Irvine, J. M.; Pucknell, V. F. E. (Manchester Univ., Eng.). pp 200 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43112 SELFCONSISTENT CALCULATION FOR THE FIRST EXCITED 0^{+}-STATE IN ^{4}He. Gutsch, U.; Beck, F. (Technische Hochschule, Darmstadt, Ger.). pp 243 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43113 LEVELS IN THE A = 5 NUCLEI EXCITED IN SINGLE AND DOUBLE NUCLEON PICK-UP REACTIONS. Baker, M. P.; Cameron, J. M.; Chant, N. S.; Mangelson, N. F.; Storm, D. W. (Univ. of Washington, Seattle). pp 260 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43114 POLARIZATION OF NEUTRONS FROM THE ^{3}H(d,n)^{4}He REACTION AT LOW DEUTERON ENERGIES. Wilhelmi, Z. (Inst. for Nuclear Research, Warsaw); Zych, W.; Zupranski, P.; Sieminski, M.; Rondio, J. pp 284 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43115 THE D(p,2p)n REACTION AT 35 MeV. Bray, K. H.; Miller, C. A.; Moss, G. A.; Wells, D. O. (Univ. of Manitoba, Winnipeg). pp 353 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43116 p-d SCATTERING AND THE EFFECTIVE RANGE EXPANSION. Birchall, J.; Blyth, C. O.; McKee, J. S. C. (Univ. of Birmingham, Eng.). pp 354 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43117 NUCLEAR DATA SHEETS. Nucl. Data, Sect. B; 4: 1-236(May 1970).

Experimental nuclear physics papers that have been published since Nuclear Data Sheets for each nucleus was last revised are indexed. The reference section is a bibliography of the articles, ordered by year of publication and last name of the first author. The key numbers and key words section is an index by nucleus to the relevant article. The index identifies the article and the experimental results given. (J.W.R.)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 43104, 43110, 43111, 43113, 43117, 43290, and 43572.

43118 (ANL-7620) PHYSICS DIVISION SUMMARY REPORT. Annual Review, April 1, 1968–March 31, 1969. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 227p. Dep. CFSTI.

ARSENIC-75 — energy level at 280 KeV lifetime of
BARIUM-131 — energy levels from (d,p) reactions, spectroscopic factors for, (E)
BARIUM-133 — energy levels from (d,p) reactions, spectroscopic factors for, (E)
BARIUM-135 — energy levels from (d,p) reactions, spectroscopic factors for, (E)
BARIUM-136 — deuteron reactions (d,p) with, angular distributions for, (E)
BARIUM-137 — energy levels from (d,p) reactions, spectroscopic factors for, (E)
BARIUM-138 — energy levels from barium-137 neutron capture, (E)
BARIUM-139 — energy levels from (d,p) reactions, spectroscopic factors for, (E)
BORON-10 — helium-3 reactions (He-3,d) at 21 MeV, angular distributions for, (E)

BORON-10 — alpha reactions (α,Be-7) and (α,Li-7) at 45 MeV, pulse-height spectra and angular distributions for, (E)
BORON-11 — helium-3 reactions (He-3,Be-7) and (He-3,Li-7) at 35 MeV, pulse-height spectra from, (E)
CADMIUM-111 — neutron capture at resonance energies, γ spectra from, (E)
CARBON-11 — energy level at 8.10 MeV, spin-parity assignment for, (E)
CARBON-12 — lithium-6 reactions (Li-6,d) at 29 MeV, deuteron spectra from, (E)
— lithium-7 reaction (Li-7,t) at 31.5 MeV, triton spectra from, (E)
— helium-3 reactions (He-3,Be-7) at 36 MeV, angular distributions for, (E)
CESIUM-134 — energy level of, lifetime of first-excited, (E)
CHLORINE-35 — deuteron reactions (d,He-3) at 23.4 MeV, helium-3 spectra from, (E)
CHLORINE-37 — deuteron reactions (d,He-3) at 23.4 MeV, helium-3 spectra from, (E)
CYCLOTRONS — design proposal for Midwest tandem, for heavy ions
DEUTERIUM IONS — energy losses in foils, channeling effects on
ELECTROSTATIC GENERATORS — operation of 4-MeV Dynamitron, for fast neutron experiments
FLUORINE-20 — energy levels from fluorine-19 (d,p) reactions, (E)
GOLD-197 — proton elastic and inelastic scattering at 12 to 18 MeV, excitation functions for, (E)
HAFNIUM-179 — energy-level transitions from hafnium-178 neutron capture, internal conversion spectra for, (E)
HELIUM IONS — helium-3 electron stripping in copper, channeling effect on
HOLMIUM-166 — energy levels from holmium-165 neutron capture, spin-parity assignments for, (E)
MAGNESIUM-24 — oxygen-16 elastic scattering at 40, 45, and 50 MeV, angular distributions for, (E)
MAGNESIUM-26 — oxygen-16 elastic scattering at 40, 45, and 50 MeV, angular distributions for, (E)
MOESSBAUER EFFECT — studies using absorber produced by neutron capture
NEON-20 — energy levels of, shell-model calculation for deformed, (T)
NUCLEAR MATTER — binding energy of, calculations using Brueckner theory and separation approximation, (T)
OXYGEN-18 — oxygen-16 elastic scattering at 30 to 50 MeV, excitation functions for, (E)
PALLADIUM-105 — energy levels and transitions from alpha Coulomb excitation, (E)
PLATINUM-196 — proton elastic and inelastic scattering at 12 to 18 MeV, excitation functions for, (E)
PLUTONIUM-240 — fission of isomeric, half-life for spontaneous, (E)
POTASSIUM-40 — energy level of, lifetime of first, excited, (E)
RUTHENIUM-103 — energy levels from ruthenium-102 (d,p) reactions, spectroscopic factors for, (E)
RUTHENIUM-105 — energy levels from ruthenium-104 (d,p) reactions, spectroscopic factors for, (E)
SAMARIUM-149 — neutron capture by, gamma energy dependence of K-conversion coefficients from, (E)
SODIUM-21 — energy levels from neon-20 (p,γ) reactions, properties of low-lying T = 3/2, (E)
TUNGSTEN-184 — proton elastic and inelastic scattering at 12 to 18 MeV, excitation functions for (E)
URANIUM-234 — fission of isomeric, half-life for spontaneous, (E)
URANIUM-235 — fission of isomeric, half-life for spontaneous, (E)
URANIUM-236 — fission of isomeric, half-life for spontaneous, (E)
VAN DE GRAAFF ACCELERATORS — operation of 12-MeV Argonne tandem
— experimental facilities at 12-MeV Argonne tandem
ZIRCONIUM-94 — helium-3 reactions (He-3,d) at 34 MeV, angular distributions for, (E) (J.W.R.)

43119 (ANU-P-484) ANNUAL REPORT, 1969. Titterton, Ernest (Australian National Univ., Canberra. Dept. of Nuclear Physics). Jan 1970. 65p. Dep. CFSTI (U. S. Sales Only).

The activities of the A. N. U. Department of Physics for 1969 are presented by its Head. The staff, their publications, research equipment and research programs are detailed. (Australia)

43120 (RLO-1388-569) THE PARITY FORBIDDEN DECAY OF THE 8.88 MeV ^{16}O STATE. Henley, E. M.; Kelliher, T. E.; Yu, D. U. L. (Washington Univ., Seattle). Apr 1970. 8p. Dep. CFSTI.

The decay rate of the 8.88-MeV state of ^{16}O is estimated with a parity-violating force involving ρ-exchange. It is pointed out that this decay can be of crucial importance for testing part of the non-leptonic weak interaction. The reason is that isospin conservation in the α decay limits the interaction responsible for the parity mixing in the initial state to the $\Delta I = 0$ parity-violating force. This force arises from the strangeness nonchanging non-leptonic weak currents. Pion exchange only contributes to the decay through radiative corrections. (auth)

43121 A COMPARISON OF POLARIZATION ANALYSING POWERS OF TWO-NUCLEON TRANSFER REACTIONS LEADING TO MIRROR FINAL STATES. Nelson, J. M.; Chant, N. S.; Fisher, P. S. (Nuclear Physics Lab., Oxford). Phys. Lett.; 31B: 445-6(30 Mar 1970).

Polarization analyzing powers and differential cross sections of (p,t) and (p,^{3}He) reactions leading to mirror states are compared. The reactions are induced by 49.5 MeV polarized protons. (auth)

43122 ENERGY DISTRIBUTION OF PHOTONEUTRONS PRODUCED BY 150-MeV ELECTRONS IN THICK BERYLLIUM AND TANTALUM TARGETS. Alsmiller, R. G. Jr.; Gabriel, T. A.; Guthrie, M. P. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng.; 40: 365-74(Jun 1970).

Electron-photon cascade calculations and photoneutron-production calculations are carried out for 150-MeV electrons on thick targets of Be and Ta. In the energy region of the giant resonance an evaporation model is used to calculate the production spectrum, and at higher energies ($\gtrsim$25 MeV) an intranuclear-cascade model is used. The calculated photoneutron-production spectra cover the energy range 0.01 to ~100 MeV and are given for target thicknesses of 1 and 20 radiation lengths in both Ta and Be. A method is described and sufficient information is given so that estimates of the photoneutron-production spectra in targets of intermediate thicknesses may be obtained. Results on the photoproton-production spectra are also given. The spectra from the Ta and Be targets are compared and are found to have very different characteristics in that the number of low-energy (<1 MeV) neutrons produced in the Ta target is much greater than that produced in the Be target and the number of high-energy ($\gtrsim$ a few MeV) neutrons produced in the Be target is larger than that produced in the Ta target. (auth)

43123 COLLECTION OF NUCLEAR REACTION PRODUCTS ON PERFORATED MATERIALS AND FILTERS. Druin, V. A.; Skobelev, N. K.; Sung-Tsing-yang, G. Ya. This paper was summarized in At. Energ. (USSR); 26: 373-4(Apr 1969) as paper No. 280. (In Russian).

The collection of the reaction products arising in the interaction of nuclei with heavy ions as knocked out in a gas volume, by adsorption of recoil atoms on various perforated materials (Teflon, nitrocellulose, nickel foil), metallic and powder-metallurgical filters, and fiber filters FP; FPP-15-0.7 and LFS-2 inserted in the flow of the evacuated gas (chiefly nitrogen) is studied. An experimental method is described which works immediately with the ion beam of a U-300 accelerator. (auth)

43124 ELASTIC SCATTERING OF ^{18}O BY ^{18}O. Shaw, R. W. Jr.; Vandenbosch, R.; Mehta, M. K. (Univ. of Washington, Seattle). Phys. Rev. Lett.; 25: 457-61(17 Aug 1970).

The excitation function at 90° c.m. has been measured between 7.5 and 27.5 MeV c.m. The prominent gross structure observed in ^{16}O–^{16}O is not seen in the present case, and the absolute cross section falls to much lower values at high energies. The results of the comparison of the two systems are discussed in terms of angular momentum restrictions on configurations directly coupled to the elastic channel. (auth)

43125 TOTAL NEUTRON CROSS SECTION ^{7}Li AND CARBON FROM 100 TO 1500 keV. Meadows, J. W.; Whalen, J. F. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 41: 351-6(Sep 1970).

A precise determination of the neutron total cross section of ^{7}Li and carbon has been made in the energy region 100 to 1500 keV. The parameters of the prominent ^{7}Li resonance in the laboratory system are E_λ = 261 keV, Γ_λ = 36.5 keV and γ_λ^2 = 594 keV. Corresponding parameters for the principal bound state resonance in carbon are E_λ = –2020 keV and γ_λ^2 = 540 keV. The carbon data are fitted by $\sigma_T = 4.830 - 3.55E + 1.587E^2 - 0.305E^3$, where σ_T is in barns and E is in MeV. Above 500 keV the ^{7}Li data are fitted by $\sigma_T = 6.929 - 27.018E + 42.721E^2 - 27.210E^3 + 6.139E^4$. (auth)

43126 INVESTIGATION OF THE 5.36-MeV LEVEL IN ^{6}Li BY ELECTRON SCATTERING. Hutcheon, R. M. (Univ., Mainz); Neuhausen, R.; Eigenbrod, F. Z. Naturforsch.; 25a: 973-4(Jun 1970).

The form factor for the excitation of the 5.36-MeV level in ^{6}Li was measured in a momentum transfer region g = 0.3 to 1.8 fm^{-1}. Calculations of this form factor were performed with L–S coupled intermediate-coupling shell model wave functions. (auth)

43127 INELASTIC ELECTRON SCATTERING FROM ^{12}C AND NUCLEAR STRUCTURE. Hiro-Oka, Masahiko (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 43: 689-95(Mar 1970).

Inelastic electron scattering from ^{12}C associated with excitation of the 15.1 MeV level is theoretically investigated. Agreement of the theory with experimental data is fairly good if the nuclear wave functions which give an excellent fit to the experimental data on the muon capture in ^{12}C and the beta decay of ^{12}B are adopted. (auth)

43128 PROTON–GAMMA ANGULAR DISTRIBUTIONS IN THE REACTION ^{19}F(p, $\alpha\gamma$)^{16}O. Willkomm, J. -J.; Klapdor, H. V. (Univ., Hamburg). Z. Phys.; 236: 424-9(1970). (In German).

The angular distributions of the 6.13-MeV γ_1 transition in the reaction ^{19}F(p, $\alpha\gamma$)^{16}O have been measured with improved accuracy at proton energies of 873 keV and 1.374 MeV using a Ge(Li) detector. The results can be fitted by Legendre polynomial series with $a_2 = -0,018 \pm 0.008$ and $a_4 = 0.000 \pm 0.008$ at $E_P = 873$ keV and $a_2 = -0.130 \pm 0.005$ and $a_4 = +0.004 \pm 0.004$ at $E_P = 1,374$ keV. From the measured Legendre coefficients α_1-angular momentum mixing ratios are extracted and compared with the results from (p, α_1) and (α_1,γ_1) correlations. (auth)

43129 SCATTERING OF IDENTICAL BOSONS. Reilly, W.; Wieland, R.; Gobbi, A.; Sachs, M. W.; Bromley, D. A. (Yale Univ., New Haven). Contract AT(30-1)-3223. pp 80 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43130 ^{19}F STATES POPULATED BY ^{18}O(p,γ) AT Ep = 1764 AND 1934 keV. Wormald, M. R.; Wright, I. F. (Univ. of Manchester, Eng.). pp 111 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43131 MEASUREMENT OF MULTIPOLE MIXTURE δ (E3/M2) OF THE TRANSITION 5.83 → 0 IN ^{14}N. Gallmann, A.; Haas, F.; Heusch, B. (Laboratoire de Physique Nucleaire, Strasbourg). pp 116 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43132 STUDY OF SOME ELECTROMAGNETIC TRANSITIONS IN ^{16}O. Brochard, F.; Chevallier, P.; Disdier, D.; Rauch, V.; Scheibling, F. (Laboratoire de Spectrometrie Nucleaire, Strasbourg). pp 125 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43133 ELECTRON SCATTERING FROM ^{13}C. Caplan, H. S.; Gupta, R. K.; Tomusiak, E. L.; Yang, C. S. (Saskatchewan Accelerator Lab., Saskatoon). pp 134 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43134 QUASI-ELASTIC SCATTERING OF HIGH-ENERGY ELECTRONS BY CARBON. Berthot, J.; Bertin, P. Y.; Girardeau-Montaut, J. P.; Isabelle, D. B. (Laboratoire de Physique Nucleaire, Clermont-Ferrand, France). pp 138 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43135 ^{15}N(p,p')^{15}N* STUDIES IN THE ^{16}O E1 GIANT RESONANCE REGION. Dracoulis, G. D.; Legge, G. J. F. (Univ. of Melbourne). pp 147 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43136 CHARGED PARTICLE EMISSION FOLLOWING PROTON CAPTURE BY ^{11}B. Thompson, W. B.; Parker, P. D. (Yale Univ., New Haven). Contract AT(30-1)-3223. pp 154 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43137 E2 EFFECTIVE CHARGES FROM REALISTIC REACTION MATRICES. Lee, H. C.; Harvey, M.; Khanna, F. C. (Chalk River Nuclear Labs., Ont.). pp 169 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43138 HARTREE–FOCK CALCULATIONS ON ^{16}O AND ^{40}Ca WITH SEMI-REALISTIC INTERACTIONS. Pearson, J. M.; Saunier, Gerard (Univ., Montreal). pp 175 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43139 CALCULATION OF SD-SHELL SPECTRA IN A = 18 NUCLEI WITH HARTREE–FOCK INTERACTIONS. Quang-Hoc, Nguyen; Pearson, J. M. (Univ., Montreal). pp 177 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43140 GROUND-STATE BINDING ENERGIES IN ^{14}C AND ^{14}N. Freed, N.; Ostrander, P. (Pennsylvania State Univ., University Park). pp 178 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43141 SIMULATION OF T = 0 REALISTIC FORCES BY PHENOMENOLOGICAL POTENTIALS. Waghmare, Y. R.; Joshi, K. P.; Mehta, G. K. (Indian Inst. of Tech., Kanpur). pp 186 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43142 POLARIZATION IN ^{11}B(p,p') AT 30.3 MeV. Karban, O.; Lowe, J.; Greaves, P. D.; Hnizdo, V. (Univ. of Birmingham, Eng.). pp 187 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43143 PREDICTIONS FOR ^{6}Li BASED ON THE HAMADA–JOHNSTON POTENTIAL. Lawson, R. D. (Argonne National Lab., Ill.). pp 190 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43144 SHELL MODEL CALCULATIONS IN ^{17}O AND A PUZZLE. Zuker, A. P. (Brookhaven National Lab., Upton, N. Y.); Buck, B.; McGr ory, J. B. pp 193 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43145 UNIQUE TWICE AND THIRD FORBIDDEN BETA DECAY. Warburton, E. K.; Garvey, G. T.; Towner, I. S. (Nuclear Physics Lab., Oxford). pp 195 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43146 EFFECT OF GROUND STATE CORRELATIONS ON NEGATIVE PARITY STATES OF ^{16}O. Goulard, B. (Univ., Laval, Quebec); Laverne, A.; Do Dang, G. pp 204 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43147 GROUND STATE PROPERTIES OF ^{16}O. Ho-Kim, Q. (Univ., Laval, Quebec). pp 206 of Contributions to the International Conference on Properties of Nuclear States,

Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43148 THE GROUND STATE OF ^{16}O. Ellis, Paul J.; Zamick, Larry (Rutgers-The State Univ., New Brunswick, N. J.). pp 213 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43149 ELECTROMAGNETIC DECAY OF FIRST AND SECOND $T = 3/2$ STATES IN ^{19}F. Aitken, J. H.; Litherland, A. E.; Dixon, W. R.; Storey, R. S.; Wong, S. S. M. (Univ. of Toronto. National Research Council, Ottawa). pp 215 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43150 SHELL MODEL FOR ^{12}C AND ^{12}B. Morita, M. (Osaka Univ); Hirooka, M.; Soga, M. pp 227 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43151 TRANSVERSE FORM FACTORS OF ^{7}Li CALCULATED WITH PROJECTED HARTREE–FOCK WAVE FUNCTIONS. Van Leuven, P.; Krueger, J. (Rijksuniversitair Centrum, Antwerp, Belg.). pp 236 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43152 HARTREE–FOCK CALCULATIONS OF THE EVEN–EVEN N = Z NUCLEI. Krieger, S. J. (Univ. of Illinois, Chicago). pp 242 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43153 RESONANCE EFFECTS IN PROTON–OXYGEN ELASTIC SCATTERING BETWEEN 16 AND 30 MeV. Karban, O. (Univ. of Birmingham, Eng.); Greaves, P. D.; Hnizdo, V.; Lowe, J.; Berovic, N.; Wojciechowski, H.; Greenlees, G. W. pp 251 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43154 $^{14}N(d,n)^{15}O$ ANGULAR DISTRIBUTIONS AND SINGLE-PARTICLE SPECTROSCOPIC FACTORS. Ritter, R. C.; Sheldon, Eric; Strang, Michael (Univ. of Virginia, Charlottesville). pp 256 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43155 INVESTIGATION OF 1p–PROTON HOLE STATES BY THE $(d,^{3}He)$-REACTION AT 52 MeV ON TARGET NUCLEI FROM ^{12}C TO ^{32}S. Kaschl, G. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Mairle, G.; Schmidt-Rohr, U.; Turek, P.; Wagner, G. J. pp 262 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43156 SPECTROSCOPIC FACTORS FOR LEVELS IN ^{11}C. Jones, D. T. L. (Univ. of Cape Town, S. Afr.); Brooks, F. D.; van Heerden, I. J. pp 269 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43157 MECHANISM OF THE $^{9}Be(p,d)^{9}Be$ REACTION. Hudson, G. M.; Kelly, D. T.; Crinean, G. B.; Rouse, J. L.; Spicer, B. M. (Univ. of Melbourne). pp 271 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43158 ANGULAR DISTRIBUTIONS IN THE REACTION $^{6}Li(p,\gamma)^{7}Be$. Johnston, G. P.; Switkowski, Z. E.; Sargood, D. G. (Univ. of Melbourne). pp 272 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43159 STUDY OF THE $^{13}C(d,t)^{12}C$ REACTION USING POLARIZED DEUTERONS. Debenham, A. A.; Griffith, J. A. R.; Irshad, M.; Roman, S. (Univ. of Birmingham, Eng.). pp 274 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43160 ENERGY DEPENDENCE OF PROTON ELASTIC SCATTERING FROM ^{16}O AND ^{40}Ca AND THE OPTICAL MODEL. van Oers, W. T. H. (Univ. of Manitoba, Winnipeg); Cameron, J. M. pp 276 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43161 l-VALUE MIXTURES IN STRIPPING REACTIONS Calvert, J. M.; Conde, C. A. N. (Manchester Univ., Eng.). pp 282 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43162 DIFFERENTIAL CROSS SECTIONS FOR THE REACTION $^{10}B(p,t)^{8}B^{*}$ AT 50 MeV. Squier, G. T. A.; Johnston, A. R. (Queen's Univ., Belfast). pp 286 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43163 THE REACTION $^{6}Li(p,^{3}He)^{4}He$. Johnston, G. P.; Sargood, D. G. (Univ., Melbourne). pp 297 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43164 PROTON-PAIR TRANSFER REACTIONS TO LEVELS IN LIGHT NUCLEI WITH MIXED CONFIGURATIONS. Honsaker, J. L. (Univ., Alberta, Edmonton); McDonald, W. J.; Neilson, G. C.; Hsu, T. H. pp 299 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43165 ENERGY LEVELS OF ^{18}Ne FROM THE $^{20}Ne(p,t)^{18}Ne$ REACTION. Falk, W. R.; Kidney, R.; Tandon, G. K.; Kulisic, P. (Univ. of Manitoba, Winnipeg). pp 301 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43166 STUDY OF SOME LEVELS OF ^{20}Ne BY THE REACTION $^{19}F(p,^{8}Be)^{12}C$. Gorodetzky, Ph.; Rudolf, G.; Scheibling, F.; Chevallier, P. (Laboratoire de Spectrometrie Nucleaire, Strasbourg). pp 302 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43167 TREIMAN–YANG TEST FOR QUASI-ELASTIC SCATTERING IN $^{6}Li(p,p'd)^{4}He$ AT 19 MeV. Liebert, R. L. (Univ. of Rochester, N. Y.); Purser, K. H.; Burman, R. L. pp 304 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43168 REACTION $^{9}Be(^{3}He,n)^{11}C$ AT AN INCIDENT ENERGY OF 4 MeV. Deschamps, Y.; Rosier, L. H.; Tamisier, R.; Avignon, P. pp 308 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43169 THE $^{7}Li(\alpha,2\alpha)^{3}H$ REACTION AT 64.3 MeV. Jain, Mahavir; Holmgren, H. D.; Pugh, H. G.; Roos, P. G. (Univ. of

Maryland, College Park). pp 3019 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43170 THE ^{7}Li(p,pα)^{3}H REACTION AT 58.1 MeV. Jain, Mahavir; Holmgren, H. D.; Pugh, H. G.; Roos, P. G. (Univ. of Maryland, College Park). pp 310 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43171 SEARCH FOR ADDITIONAL T = $\frac{3}{2}$ STATES IN ^{17}F. Skwiersky, B. M.; Chesterfield, C. M.; Parker, P. D. (Yale Univ., New Haven). pp 317 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43172 COULOMB ENERGIES AND NUCLEAR RADII. Nolen, J. A. Jr.; Schiffer, J. P. (Argonne National Lab., Ill.). pp 321 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43173 INTERPRETATION OF THE I-SPIN ANALOGUE STATES IN A = 10 TRIAD. Connors, P.; Cooper, M.; Mo, T.; Roush, M.; Tu, H.; Young, F.; Hornyak, W. F. (Univ. of Maryland, College Park). pp 327 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43174 I-SPIN ANALOGUE STATES IN A = 10 TRIAD. Connors, P.; Cooper, M.; Mo, T.; Roush, M.; Tu, H.; Young, F.; Hornyak, W. F. (Univ. of Maryland, College Park). pp 328 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43175 ON EVEN PARITY STATES OF ^{17}O. Fowler, J. L. (Oak Ridge National Lab., Tenn.). pp 334 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43176 THE GROUND STATE OF ^{8}Be. Kermode, M. W. (McMaster Univ., Hamilton, Ont.). pp 336 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43177 PARTICLE-HOLE DESCRIPTION OF THE GIANT DIPOLE RESONANCE OF ^{12}C IN THE EQUATIONS-OF-MOTION FORMALISM. Wong, S. S. M.; Rowe, D. J. (Univ. of Toronto). pp 342 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43178 MUON CAPTURE AND THE GROUND STATE OF ^{16}O. Green, A. M. (Univ. of Helsinki); Kallio, A. pp 343 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43179 PARTICLE–HOLE EXCITATION IN THE 2s-1d SHELL. Ellis, P. J. (Rutgers–The State Univ., New Brunswick, N. J.); Engeland, T. pp 344 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43180 EFFECT OF GROUND-STATE CORRELATION ON THE 3^{-} EXCITATION OF ^{16}O. Rowe, D. J.; Ullah, N. (Univ. of Toronto). pp 348 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43181 ASYMMETRY OF T = 0 RESONANCES IN THE GIANT DIPOLE RESONANCE IN LIGHT EVEN–EVEN NUCLEI. Mahaux, C. (Univ., Liege); Saruis, A. M. pp 356 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43182 (P,2P) REACTIONS AND SINGLE-PARTICLE LEVELS. James, A. N. (Univ. of Liverpool). pp 515-28 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

Protons of 387 MeV were used to study (p,2p) reactions in several nuclei. The measurements cover a wide range of energy and recoil momentum and can be interpreted in terms of single particle states. The binding energy of 1S in calcium-40 is located near 50 MeV. (auth) (Canada)

Nuclear Properties and Reactions, 20 ≤ A ≤ 89

Refer also to abstracts 42991, 43104, 43105, 43109, 43111, 43117, 43119, 43123, 43137, 43138, 43145, 43152, 43155, 43160, 43165, 43172, 43182, 43313, 43471, 43555, 43561, 43565, 43566, 43570, and 43576.

43183 (CONF-700101–(Vol.2), pp 1257-68) ELASTIC NEUTRON INTERACTION MEASUREMENTS WITH A MODERATED BOMB SOURCE SPECTRUM. Hoffman, Marvin M. (Los Alamos Scientific Lab., N. Mex.).
From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14–16, 1970. Proceedings.

Experimental measurements of the neutron flux elastically scattered from medium and high mass nuclei have yielded excellent cross-section data over a wide range of neutron energies. The moderated bomb spectrum which comprises the neutron source function provides ample flux for cross-section measurements between energies of 60 eV to 3 MeV. Analyses of the compound elastic scattering data show that the time dependence of the neutron source function contributes to a time-of-flight energy distribution which is approximately Poisson. The full width of the distribution at half the peak value exceeds one percent of the time-of-flight energy. Area analyses of the measured elastic cross sections yield resonance parameters for energies up to the 100 keV region. A careful study of the applicability of shape analysis to these data reveals that a reduction in the width of the neutron source function would be highly advantageous and has led to additional calculations of moderator design. Results of some data analysis, moderator design and shielding calculations are presented. (auth)

43184 (IFA-M-45) PHOTONEUTRON CROSS SECTION FOR ^{59}Co AND ITS FINE STRUCTURE. Baciu, G.; Catana, D.; Deberth, C.; Iliescu, C.; Cirstoiu, B. (Institutul de Fizica Atomica, Bucharest (Romania)). 1970. 5p. Dep. CFSTI (U. S. Sales Only).

The cross section for the ^{59}Co(γ, Σn) reaction has been measured from threshold to 22 MeV with a small energy bin (100 keV). Marked structure was observed in the total photoneutron cross section at several energies below and in the giant resonance. This structure of the cross section is ascribed to the dipole-quadrupole coupling influence. (auth)

43185 (ORNL–4518) NEUTRON ELASTIC- AND INELASTIC-SCATTERING CROSS SECTIONS FOR Na IN THE RANGE OF 5.4 TO 8.4 MeV. Perey, F. G.; Kinney, W. E. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 64p. Dep. CFSTI.

Numerical values are presented for neutron elastic- and inelastic-scattering cross sections for Na for incident energies from 5.4 to 8.5 MeV. In this energy region there exists only one previous measurement, at 7 MeV, for the inelastic scattering to the first excited state. This datum point is consistent with the results. Two ENDF/B evaluations for Na are compared with the data. Both evaluations are in fairly good agreement with the integrated elastic cross sections but give poorer agreement for the differential elastic cross sections. For the inelastic-scattering cross sections, one of the evaluations does not go above 5 MeV

and the other, although it reproduces the cross section for the first excited state fairly well, fails to reproduce the decrease in the inelastic cross sections as a function of energy for the other levels. (auth)

43186 (RLO-1925-34) SEARCH FOR AN EXCITED PROLATE ROTATIONAL BAND IN ^{28}Si. Huang, F. C. P.; Gibson, E. F.; McDaniels, D. K. (Oregon Univ., Eugene. Dept. of Physics). [1970]. 31p. Dep. CFSTI.

Lifetime and branching ratio studies were made in ^{28}Si utilizing the ^{27}Al(p, γ) ^{28}Si reaction. Principal emphasis was given to measurements on levels at 7380, 7416, 7935, 8328, and 9163 keV as possible candidates for the 2^+ state of an excited prolate rotational band. Combining these lifetime and branching ratio results to obtain E^2 transition strengths for inter- and intra-band transitions leads to the conclusion that an excited prolate rotational band is an unlikely possibility. Lifetimes of the 8328-keV and the 9415-keV states were measured as 150^{+120}_{-60} fsec and 130^{+75}_{-50} fsec, respectively. A remeasurement of the lifetime of the 0^+ level at 4975 keV is in substantial agreement with earlier work. Excitation of the interesting 6^+ member of the ground state rotational band was observed at the 2203-keV resonance. (auth)

43187 CALCULATED ^{56}Fe NEUTRON ELASTIC AND INELASTIC SCATTERING AND GAMMA-RAY-PRODUCTION CROSS SECTIONS FROM 1.0 TO 7.6 MeV. Kinney, W. E.; Perey, F. G. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng.; 40: 396-406 (Jun 1970).

Measurements of neutron elastic and inelastic scattering from ^{56}Fe are analyzed theoretically. The shape-elastic-scattering cross sections, calculated with an optical-model potential using energy-independent parameters, add to the compound-elastic contribution obtained from a Hauser–Feshbach calculation, including width fluctuation corrections, agree reasonably well with the data from 4 to 7.6 MeV. Inelastic-scattering cross sections from the Hauser–Feshbach calculation agree well with the data from 1 to 7.6 MeV. From the known branching ratios for the decay of the levels of ^{56}Fe, calculated gamma-ray-production cross sections are in reasonable agreement with the data. It is suggested that such calculations form the basis for consistent sets of (n,n') and (n,n'γ) cross sections for shielding calculations. (auth)

43188 TOTAL NEUTRON CROSS SECTIONS OF $^{46-50}$Ti FOR THERMAL AND EPITHERMAL NEUTRONS. Doil'nitsyn, E. Ya.; Stupak, A. I. This paper was summarized in At. Energ. (USSR); 27: 144(Aug 1969) as paper No. 331/5273. (In Russian).

A description is given of measurements of the total neutron cross sections of $^{46-50}$Ti in the thermal and epithermal neutron region. The measurements are made by the time of flight method with a mechanical selector. In the thermal region the absorption cross sections σ_c vary with the energy according to a 1/V law. On the basis of the results of measurements of the total neutron cross sections the absorption cross sections for $^{46-49}$Ti are determined at the energy E = 0.025 eV and the cross sections for scattering of thermal neutrons by rigidly bound atoms of the titanium isotopes. (auth)

43189 STATISTICAL AND NON-STATISTICAL EFFECTS IN THE α-SCATTERING FROM ^{24}Mg BETWEEN 14.9 AND 19.1 MeV. Eberhard, K. A. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Mayer-Boericke, C. Nucl. Phys.; A142: 113-36(1970).

Angular distributions for the elastic (α_0) and inelastic (α_1, α_2, α_3) α-scattering by ^{24}Mg have been measured in the angular range 25° – 165° in 5° steps in the lab system. The energy range covered in 20 keV steps in 14.9–19.1 MeV for the α_0 and α_1 data, and 15.4–19.1 MeV for the α_2 and α_3 data. The measured cross sections fluctuate rapidly as a function of energy, and the statistical origin of most of the structures has been proved for all excitation curves. The mean width Γ of the ^{28}Si levels and the mean normalized variance $C_{\epsilon=0}(\theta)$ have been determined by using auto-correlation functions and Fourier analyses. The results from both methods are in good agreement. The mean level width Γ is 61 keV. The direct reaction cross section contributes considerably to the measured α_0 to α_3 cross sections. The ratio Γ_J/D_J for J = 8 has been estimated by a Hauser–Feshbach calculation. Angular cross correlations show non-statistical effects. The occurrence of non-statistical effects in the excitation curves is discussed. (auth)

43190 COULOMB EXCITATION AND THE REORIENTATION EFFECT IN ^{70}Ge AND ^{76}Ge. Simpson, J. J.; Smilansky, U.; Ashery, D. (Weizmann Inst. of Sciene, Rehovot, Israel). Nucl. Phys.; A138: 529-44(1969).

Measurements of the Coulomb excitation probabilities of the first 2^+ states in ^{70}Ge and ^{76}Ge have been made with ^{4}He and ^{16}O projectiles. Using the theory of the multiple Coulomb excitation process the values of the B(E2, $0^+ \rightarrow 2^+$) and the static quadrupole moment of the 2^+ states were deduced. The values of the quadrupole moments depend on the choice of the sign for the matrix element of the E2 operator to the higher 2^+ states. For either choice of this sign, the values obtained are small compared with the rotational values. (auth)

43191 THE DEPENDENCE OF THE SPECTROSCOPIC FACTORS ON PARAMETERS OF DISTORTING POTENTIALS FOR THE REACTION ^{26}Mg(τ,α)^{25}Mg. Nurzynski, J. (Australian National Univ., Canberra). Nucl. Phys.; A141: 257-72(1970).

Angular distributions of α-particles from the reaction ^{26}Mg(^{3}He, α)^{25}Mg studied at E_τ = 10.2 MeV have been analyzed in terms of DWBA. To avoid the necessity of introducing a lower cut-off radius in the calculation of radial integrals, deep potentials have been used. Changes in the potential of the incident particles are found to have only a small influence on the calculated distributions. The fits to the experimental data can be optimized by readjusting one parameter only, namely the depth of the real part of the optical-model potential for α-particles. The present analysis indicates that the dependence of the ratio of the spectroscopic factors $S(l,j)/S_{g.s.}(l,j)$ on the exit channel parameters is weaker (by a factor of from 0.5 to 0.2) than the dependence of the absolute value of the calculated cross sections on the same parameters. The experimental value of the normalization coefficient D_0^2 obtained here for the (^{3}He,α) reactions is 22 ± 6. (auth)

43192 SHELL-MODEL CALCULATION OF MULTIPOLE TRANSITIONS IN ^{88}Sr. Shastry, S. (State University of New York Coll., Plattsburgh). Nucl. Phys.; A142: 12-20(1970).

A finite range force calculation using Gaussian radial dependence and employing Rosenfeld exchange mixture has been performed to calculate the various multipole transition rates in ^{88}Sr. Fine agreement is obtained for the collective quadrupole and octupole states. In addition the dipole transition ($3^- \rightarrow 2^+$) having a hindrance factor of 3.8×10^{-3} is also found to be in very good agreement with the experiment. (auth)

43193 THE ISOMERIC DECAY OF ^{73}Se. Konijn, J.; Klank, B.; Spenny, D. L.; Ristinen, R. A. (Univ. of Colorado, Boulder). Nucl. Phys.; A138: 577-82(1969).

The energy of the isomeric transition in ^{73m}Se was measured as 25.71 ± 0.04 keV with a double-focusing beta-ray spectrometer. From the L/K conversion electron ratio a unique E3 multipole assignment can be made. From coincidence experiments between L conversion electrons and the low-energy gamma-ray spectrum it is concluded that no gamma-ray transition occurs in cascade with the isomeric decay. (auth)

43194 GAMMA DECAY OF ISOBARIC ANALOG STATES IN ^{56}Fe. Friedrich, R.; Kiessling, M.; Otto, G. (Karl-Marx-Univ., Leipzig). Ann. Phys. (Leipzig); 23: 168-79(Jul 1969). (In German).

The γ-ray decay of six isobaric analog states in ^{56}Fe known from the reaction ^{55}Mn(p,γ)^{56}Fe was measured with a Ge(Li) detector. One of these states was investigated in three fine structures. A Q value of (10189 ± 7) keV was obtained for this reaction. A ^{56}Fe level scheme up to excitation energy of 6450 keV was deduced. Consideration of configuration states of three analog states yields isobaric spin potential and isobaric spin impurity. The strong coupling between the doorway state and the background states is seen in the very distinguished fine structure spectra. (auth)

43195 LIFETIMES OF LOW-LYING LEVELS IN ^{57}Ni. Gould, C. R. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.); Hagen, E. C.; Poore, R. V.; Roberson, N. R.; Mitchell, G. E.; Tilley, D. R. Phys. Rev. Lett.; 25: 463-6(17 Aug 1970).

Lifetimes of low-lying levels in ^{57}Ni have been investigated using the reaction ^{54}Fe(α,n)^{57}Ni and the Doppler-shift attenuation method. The lifetimes are not in agreement with single-particle predictions and, together with the presence of new low-lying levels in ^{57}Ni, confirm the presence of core excitation of ^{56}Ni. (auth)

43196 ENERGY-DEPENDENT CIRCULAR POLARIZATION AND NUCLEAR MATRIX ELEMENTS OF ^{86}Rb. Bosken, Jerome Joseph. Lafayette, Ind.; Purdue Univ. (1969). 127p.

Thesis.

Previous work has shown that a measurement of the circular polarization of the 1.08-MeV gamma ray of ^{86}Rb as a function of the energy of the accompanying beta particle will restrict the values of the nuclear matrix elements of the .70-MeV beta transition. This measurement was performed using the technique of forward Compton scattering from magnetized iron. Special high counting rate electronics and stabilizing tachniques have been employed to obtain the required accuracy. Previously available data on spectrum shape, energy dependence of the directional correlation, and angular dependence of the circular polarization

were used together with data from this experiment to determine the nuclear matrix elements. It was found that the ratio of the matrix elements $\int\tilde{\alpha}$ to $\int 1\tilde{r}$ agrees with the predictions of CVC theory to within 20%. Previously a ratio which was 80% higher than the theoretical prediction could not be excluded. (Diss. Abstr. Int., B)

43197 3d → 2p PIONIC TRANSITION IN ^{58}Ni AND ^{60}Ni. Jenkins, D. A. (Virginia Polytechnic Inst., Blacksburg); Powers, R. J.; Miller, G. H. Phys. Rev.; 185: 1508-14(20 Sep 1969).

The 3d → 2p pionic x rays in ^{58}Ni and ^{60}Ni were observed in order to measure effects due to the strong interaction between the pion and the nucleus. These isotopes were chosen because nuclear effects in the x-ray energy are expected to be large and the x-ray yield is appreciable. A large nuclear level shift and broadening is seen but no isotope effect is seen within experimental error. The level shift is found to have a strong dependence on the neutron radius, and the results are consistent with the hypothesis of equal neutron and proton rms radii. The isotope shift for the 2p → 1s transition in ^{16}O and ^{18}O is computed. Experimental measurements require the neutron radius of ^{18}O to be greater than the neutron radius of ^{16}O. However, uncertainties in the pion–nuclear interaction do not allow an accurate determination of the neutron radius. (auth)

43198 ^{31}P(p,γ)^{32}S REACTION IN THE PROTON ENERGY RANGE 2000 TO 2400 keV. Forsblom, I.; Paukku, P.; Penttinen, S. (Univ. of Helsinki). Commentat. Phys.-Math.; 40: 1-8(Jun 1970).

The ^{31}P(p,γ)^{32}S reaction was investigated at E_p = 2020, 2023, 2133, 2212, 2301, 2329, and 2350 keV. The J^π value of the 2301-keV resonance level has been proposed as 2^4 and one member of the doublet resonance at 2350 keV has $J^\pi = 2^+$. At the resonance E_p = 2133 keV a new bound state 6849 keV is found, which decays to the 4281-keV level by 70%, to the 4460-keV level by 20%, and to the 5410-keV level by 10%. The decay schemes of the following bound states have been proposed: 7348, 7701, and 8294 keV. The decays of fourteen bound states have been remeasured. (auth)

43199 LOW-LYING ODD PARITY STATES OF ^{46}Sc. Raju, B. B. V.; Spicer, B. M. (Melbourne Univ., Parkville, Australia). Aust. J. Phys.; 23: 255-60(Jun 1970).

In ^{46}Sc the low-lying odd-parity states are populated in reactions other than those leading to the even-parity states. The radiative transitions between these low-lying states have been studied in the reaction ^{45}Sc(n,γ); from this it is suggested that the low-lying odd-parity states form a rotational band. Evidence to support this hypothesis is presented, and some of its consequences are discussed. (Australia)

43200 SPIN AND PARITY OF THE 1644 keV STATE IN ^{40}K. Kolata, J. J.; Shapiro, P.; August, L. S. (Naval Research Lab., Washington, D. C.). Phys. Lett.; 32B: 277-9(6 Jul 1970).

An angular distribution has been obtained for the ^{42}Ca(p,^{3}He) reaction to the 1644-keV state in ^{40}K at an incident proton energy of 40.0 MeV. Previous investigations have resulted in conflicting spin and parity assignments for this level. The characteristic l = 0 shape of the present distribution and the fact that the state is not excited in the (d,α) reaction confirm the previous $J^\pi = 0^+$ assignment. (auth)

43201 SPIN ASSIGNMENT FOR THE 1.89 MeV LEVEL IN ^{42}Sc. Fahrbach, H. U.; Alberts, W. G.; Bodenmiller, K. H.; Buhl, S. (Univ., Heidelberg). Z. Phys.; 235: 265-70(1970).

The gamma decay mode and the spin value of the 1.89-MeV state of ^{42}Sc were investigated by studying the ^{40}Ca(^{3}He,pγ)^{42}Sc reaction at 10.0 MeV energy of the incident ^{3}He beam. The analysis of the p-γ angular correlation of the 1.89-MeV ground state transition, using method II of Litherland and Ferguson, yields the spin assignment J = 1 for this level. (auth)

4326 COULOMB SCATTERING OF 1 MeV ELECTRONS IN ALUMINUM FOILS. Berger, Ch.; Knop, G.; Kofink, H.; Menze, D.; Schulz, W. (Univ., Bonn). Z. Phys.; 235: 191-204(1970).

Electrons of a kinetic energy of 1 MeV were used to measure the angular dependence of the scattering cross section in thin aluminum foils. After correction for multiple scattering the results were compared with theoretical calculations including the radiative corrections. The measurements were found to agree with theory within ±1%. (auth)

43203 MEASUREMENT OF HALF LIVES OF ^{60}Co, ^{137}Cs, AND ^{133}Ba. Walz, K. F.; Weiss, H. M. (Physikalisch-Technische Bundesanstalt, Brunswick). Z. Naturforsch.; 25a: 921-7(Jun 1970). (In German).

The half-lives of ^{60}Co, ^{137}Cs and ^{133}Ba have been evaluated from measurements of the activities of samples against the activity of a ^{226}Ra-standard by means of a 4 π-γ-ionization chamber during a period of about 3 years. A least squares fit together with corrections for the decay of ^{226}Ra contaminations, and saturation defects leads to the following results:

^{60}Co: $T_{\frac{1}{2}}$ = (5,2719 ± 0,0011) a;
^{133}Ba: $T_{\frac{1}{2}}$ = (10,352 ± 0,040) a;
^{137}Cs: $T_{\frac{1}{2}}$ = (29,901 ± 0,045) a. (auth)

43204 ON THE DECAY OF BROMINE ISOTOPES ^{86}Br AND ^{87}Br. Lundan, A. (Technical Univ. of Helsinki, Otaniemi, Finland). Z. Phys.; 236: 403-9(1970).

Gamma spectra of a mixture of the isotopes ^{86}Br and ^{87}Br were measured by means of a Ge(Li) detector. Both manual and automated techniques were used to separate bromine from other fission products of natural uranium. A total of 13 gamma rays was observed. The most intense of the ^{86}Br gamma peaks (1,565 keV) was found to grow in with a half-life of 4.5 ± 1 s. This is explained to be due to an isomeric state in ^{86}Br decaying to the ground state. (auth)

43205 THE DECAY OF ^{73}Br. Murray, G. (Univ. of Manchester, Eng.); White, W. J. K.; Willmott, J. C.; Entwistle, R. F. Nucl. Phys.; A142: 21-34(1970).

The energies and relative intensities of the γ-rays following the radioactive decay of 3.3 min ^{73}Br produced by the ^{59}Co(^{16}O,2n) reaction have been measured using Ge(Li) detectors. No isomeric transition with half-life greater than 1 ms has been observed in ^{73}Br. A level scheme for ^{73}Se is proposed. The results are discussed in the light of observed correlations of the variations in the B(E2) values and the excitation energies of the first 2^+ states in doubly even nuclei and the excitation energies of the first $\frac{9}{2}^+$ states in odd-proton nuclei in the region Z, N = 28 and Z, N = 50. (auth)

43206 THE DECAY OF 3.2-SEC ^{58}Cu. Raman, Subramanian (Oak Ridge National Lab., Tenn.). pp 3 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43207 PROPERTIES OF EXCITED STATES IN ^{62}Ni STUDIED BY THE (n,γ) REACTION. Fanger, U.; Gaeta, R.; Michaelis, W.; Ottmar, H.; Schmidt, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 4 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43208 COLLECTIVE CALCULATIONS IN ^{23}Na. Lindgren, R. A.; Pronko, J. G.; Bromley, D. A. (Yale Univ., New Haven). Contract AT(30-1)-3223. pp 15 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43209 ZERO SPIN FOR THE 1482.6-keV LEVEL IN ^{74}Ge FROM γ–γ(0). Coffman, F. E. (Vanderbilt Univ., Nashville, Tenn.); Hamilton, J. H.; Ramayya, A. V.; Johnson, N. R. pp 30 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43210 COLLECTIVE NATURE OF THE SECOND 2^+ STATE IN ^{32}S. Sargent, B. W.; Leslie, J. R.; Montague, J. H. (Queen's Univ., Kingston, Ont.). pp 31 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43211 ^{35}Cl IN A VIBRATIONAL MODEL. Castel, B.; Stewart, K. W. C. (Queen's Univ., Kingston, Ont.). pp 45 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43212 INVESTIGATIONS OF THE LEVEL SCHEMES OF THE SPHERICAL NUCLEI OF $^{80\ 81\ 82\ 83}$Kr AND $^{80\ 81}$Rb. Broda, R.; Hrynkiewicz, A. Z.; Styczen, J.; Walus, W. (Inst. of Nuclear Physics, Cracow, USSR. Joint Inst. for Nuclear Research, Dubna, USSR). pp 46 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43213 RETARDATION OF ALLOWED BETA DECAYS TO EXCITED 0^+ STATES IN EVEN–EVEN NUCLEI. Hamilton, J. H. (Vanderbilt Univ., Nashville, Tenn.). pp 51 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43214 CONTRIBUTION ON THE STUDY OF THE β^+ DECAY OF NUCLEI OF MASS A = 4n + 2. Gallmann, A.; Aslanides, E.; Jundt, F. (Laboratoire de Physique Nucleaire et d'Instrumentation Nucleaire, Strasbourg). pp 54 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43215 MAGNETIC MOMENTS OF THE FIRST EXCITED 2^+ STATES IN ^{58}Fe AND ^{132}Xe. Singh, Vikram (Kurukshetra Univ., India); Tandon, P. N.; Devare, S. H.; Devare, H. G. pp 88 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43216 MAGNETIC MOMENT OF THE 310-keV STATE IN ^{49}V. Patnaik, Bijoy K. (Carnegie Mellon Univ., Pittsburgh); Gangadharan, S.; Jha, S. pp 90 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43217 SPINS AND NUCLEAR MOMENTS OF ^{60m}Co, ^{140}La, AND ^{142m}Pr. Hussein, S. G.; Pierce, A. R.; Robertson, R. G. H.; Summers-Gill, R. G. (McMaster Univ., Hamilton, Ont.). pp 91 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43218 RELATIVE STATIC QUADRUPOLE MOMENTS IN Ni ISOTOPES. Lesser, P. M. S.; Cline, D.; Purvis, J. D. (Univ. of Rochester, New York). pp 92 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43219 QUADRUPOLE MOMENT OF THE FIRST EXCITED STATE OF ^{20}Ne. Nakai, K.; Stephens, F. S.; Diamond, R. M. (Univ. of California, Berkeley). pp 93 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43220 MEASUREMENT OF THE QUADRUPOLE MOMENT OF THE FIRST EXCITED STATE IN ^{48}Ti. Haeusser, O. (Chalk River Nuclear Labs., Ont.); Pelte, D.; Alexander, T. K.; Evans, H. C. pp 94 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43221 ELECTROMAGNETIC TRANSITIONS IN ^{53}Cr. Carola, T. P. G.; Olsen, W. C.; Twin, P. J. (Univ. of Alberta, Edmonton). pp 100 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43222 HIGH SPIN STATES IN ^{55}Fe. Pilt, A. A.; Sheppard, D. M.; Twin, P. J.; Olsen, W. C. (Univ. of Alberta, Edmonton). pp 101 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43223 POSITIVE PARITY STATES IN ^{49}K. Twin, P. J.; Olsen, W. C.; Wong, E. (Univ. of Alberta, Edmonton). pp 102 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43224 SPIN ASSIGNMENTS OF STATES IN ^{24}Mg. FROM AN ANALYSIS OF DOPPLER BROADENED GAMMA RAYS. Krone, R. W.; Cockburn, P. M.; Stark, W. J. (Univ. of Kansas, Lawrence). pp 104 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43225 LIFETIMES OF EXCITED NUCLEAR STATES. Bozek, E. (Inst. of Nuclear Physics, Cracow, Poland); Broda, R.; Golczewski, J.; Hrynkiewioz, A. Z.; Styczen, J.; Kulessa, R.; Walus, W. pp 107 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43226 THE MASS AND SOME STATES OF ^{44}Ti FROM THE ^{40}Ca(α,γ)^{44}Ti REACTION. Simpson, J. J. (Univ. of Toronto); Dixon, W. R.; Storey, R. S. pp 108 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43227 THE USE OF NUCLEAR ORIENTATION IN NEUTRON CAPTURE GAMMA RAY SPECTROSCOPY: LEVELS OF ^{150}Sm AND ^{56}Mn. Postma, H.; Reddingius, E. R.; Mellema, J. (Kamerlingh Onnes Lab., Leiden). pp 109 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43228 STUDY OF THE ENERGY LEVELS OF ^{75}As USING NUCLEAR PHOTOEXCITATION. Moreh, R.; Shahal, O. (Nuclear Research Centre, Negev, Israel). pp 110 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43229 LIFETIMES AND BRANCHING RATIOS OF ^{24}Mg ROTATIONAL STATES. Branford, D.; Gardner, N.; Wright, I. F. (Univ. of Manchester, Eng.). pp 112 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43230 LIFETIMES IN ^{30}Si AND ^{30}P. James, A. N.; Sharpey-Schafer, J. F.; Alderson, P. R.; Bailey, D. C.; Durell, J. L.; Greene, M. W. (Univ. of Liverpool). pp 113 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43231 VIBRATIONAL STATES IN ^{34}S. Greene, M. W.; James, A. N.; Alderson, P. R.; Bailey, D. C.; Durell, J. L.; Green, L. L.; Sharpey-Schafer, J. F. (Univ. of Liverpool). pp 114 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43232 TRANSITION RATES IN ^{29}P. Monahan, C. F.; Evans, H. C.; Montague, J. H.; Paulson, W. R. (Queen's Univ., Kingston, Can.). pp 118 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43233 SPINS OF THE I = 1 STATES IN ^{55}Co. Cujec, B.; Dayras, R. (Univ., Laval, Quebec). pp 120 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43234 GAMMA RAY STUDY OF SOME LEVELS IN ^{41}Ca. Johnson, G.; Blake, R. S.; Laurent, H.; Picard, F.; Schapira, J. P. (Inst. de Physique Nucleaire, Orsay, France). pp 121 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43235 CLASSIFICATION OF ^{40}Ca LEVELS DEDUCED IN THE REACTIONS ^{39}K(^{3}He,dγ)^{40}Ca AND ^{40}Ca(p,p′γ). Tellez, A.; Ballini, R. (CEN, Saclay, France). pp 122 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43236 PROPERTIES OF CLOSE DOUBLETS IN ^{60}Ni. Van Patter, D. M.; Scott, H. L.; Moazed, C. (Franklin Inst., Swarthmore, Pa.). pp 124 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43237 NUCLEAR RESONANCE FLUORESCENCE WITH COMPTON SCATTERED RADIATION. Celliers, P. J.; Hough, J. H.; Koen, J. W.; Mouton, W. L. (Univ. of Stellenbosch, S. Afr.). pp 126 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43238 THE SPINS OF THE 4.41- AND 4.51-MeV LEVELS OF ^{27}Al. Spear, R. H.; Piluso, C. J.; Kean, D. C.; Carter, K. W. (Australian National Univ., Canberra). pp 127 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43239 THERMAL NEUTRON CAPTURE γ-RAYS FROM ^{45}Sc. Raju, B. B. V.; Spicer, B. M. (Univ. of Melbourne). pp 129 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43240 MULTIPLETS AT 4.10 AND 4.44 MeV EXCITATION IN ^{42}Ca. Tellez, A.; Ballini, R.; Delaunay, J.; Fouan, J. P. (CEN, Saclay, France). pp 130 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43241 ELECTROMAGNETIC DEEXCITATION OF SOME PARTICULAR LEVELS IN ^{58}Ni. Beuzit, P.; Delaunay, J.; Fouan, J. P.; Ronsin, H. (CEN, Saclay, France). pp 131 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43242 THE SPINS OF SOME EXCITED STATES OF ^{41}Ar. Kopecky, J.; Stecher-Rasmussen, F.; Abrahams, K. (Reactor Centrum Nederland, Petten, Netherlands). pp 133 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43243 E2 AND E3 TRANSITION RATES IN ^{24}Mg, ^{40}Ca, AND ^{39}K. Alexander, T. K.; Broude, C.; Haeusser, O.; Pelte, D. (Chalk River Nuclear Labs., Can.). pp 137 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43244 THE LOW-LYING EXCITED STATES OF ^{22}Mg. Rolfs, C.; Riess, F.; Kraemer, R.; Juhlmann, E. (Physikalisches Inst., Freiburg i. B.). pp 139 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43245 EVIDENCE FOR A d-WAVE RESONANCE IN ^{48}Ti. Broomhall, G. J. (Univ. of Melbourne). pp 141 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43246 COULOMB EXCITATION OF THE EXCITED 0^{+} STATE IN ^{70}Ge WITH ^{35}Cl IONS. Simpson, J. J. (Univ. of Toronto); Ward, D.; Ewan, G. T. pp 142 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43247 THE I = 3 AND 4 TRANSITIONS IN INELASTIC SCATTERING OF PROTONS FROM ^{66}Zn. Yagi, K. (Osaka Univ.); Saji, Y.; Ishizaki, Y.; Ishimatsu, T.; Nakajima, Y.; Matoba, M.; Huang, C. Y. pp 145 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43248 POLARIZATION IN THE ELASTIC SCATTERING OF 12.3-MeV DEUTERONS. Griffith, J. A. R.; Irshad, M.; Karban, O.; Oh, S. W.; Roman, S. (Univ. of Birmingham, Eng.). pp 146 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43249 OCTUPOLE AND QUADRUPOLE TRANSITIONS IN EVEN–STABLE TITANIUM ISOTOPES INDUCED BY INELASTIC PROTON SCATTERING. Cardinal, C. U.; De Castro Faria, N. V.; Levesque, R. J. (Univ., Montreal). pp 148 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43250 COUPLED CHANNEL CALCULATION OF ELASTIC AND INELASTIC SCATTERING OF 17.5-MeV PROTONS BY ^{23}Na. Ottaviani, P. L.; Zuffi, L. (Comitato Nazionale Energia Nucleare, Bologna). pp 149 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43251 DEUTERON INTERACTIONS IN THE $D_{\frac{5}{2}}$ SUBSHELL. Mermaz, M. C.; Whitten, C. A. Jr.; Bromley, D. A. (Yale Univ., New Haven). Contract AT(30-1)-3223. pp 150 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43252 EFFECTS OF α-PARTICLE CORRELATIONS IN α SCATTERING. Gaul, G. (Max Planck Institut fuer Kernphysik, Heidelberg); Luedecke, H.; Santo, R.; Schmeing, H.; Stock, R. pp 153 of Contributions to the International Conference of Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43253 THE INELASTIC SCATTERING OF 26.5-MeV ALPHA PARTICLES ON ^{28}Si, ^{31}P, AND ^{32}S NUCLEI IN THE REGION OF ANGLES FROM 20^{0} UP TO 178^{0}. Budzanowski, A.; Chyla, K.; Grotowski, K.; Niewodniczanski, H.; Strazalkowski, A.; Szymakowski, J.; Tomza, U.; Wojciechowski, H. (Silesian Univ., Katowice, Poland). pp 155 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43254 SPIN DEPENDENCE IN INELASTIC DEUTERON SCATTERING. Legg, J. C. (Kansas State Univ., Manhattan); Yntema, J. L.; Bearse, R. C.; Fortune, H. T. pp 157 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43255 CORE POLARIZATION IN INELASTIC PROTON SCATTERING. Petrovich, F.; McManus, H.; Borysowicz, J. (Michigan State Univ., East Lansing). pp 188 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43256 M2 AND E3 TRANSITIONS IN THE RANGE $33 \leq A \leq 41$. Harris, Gale I. (Aerospace Research Labs., Wright Patterson AFB, Ohio). pp 192 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43257 NEGATIVE PARITY STATES IN ^{30}P. Watson, D. D.; Harris, Gale I. (Aerospace Research Labs., Wright Patterson AFB, Ohio). pp 196 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43258 ENERGY LEVELS OF ^{41}Ar. Cornell, J. C. (Univ. of Cape Town, S. Afr.); Brooks, F. D.; McMurray, W. R. pp 197 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43259 THE ANALOGUES OF 4 PARTICLE–4 HOLE STATE OF ^{16}O IN 2s–1d SHELL NUCLEI. Struble, G. L.; Tewari, S. N. (Univ. of California, Berkeley). pp 199 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43260 THEORETICAL STUDY OF THE $1/2^-$, $3/2^-$, $5/2^-$, AND $7/2^-$ STATES OF ^{51}Ti. Divadeenam, M.; Beres, W. P. (Duke Univ., Durham, N. C.). pp 201 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43261 NUCLEAR STRUCTURE INFORMATION FROM THE γ-DECAY OF THE LOWEST $3/2^-$ ANALOGUE STATE IN ^{51}V. Osnes, E. (NORDITA, Copenhagen); Warke, C. S. pp 202 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43262 THE GIANT DIPOLE RESONANCES IN ^{20}Ne. Ho-Kim, Q. (Univ., Laval, Quebec). pp 207 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43263 HF CALCULATIONS FOR ^{20}Ne AND ^{28}Si WITH MORE OR LESS REALISTIC INTERACTIONS. Wong, S. K. M.; LeTourneux, J.; Quang-Hoc, N.; Saunier, G. (Univ., Montreal). pp 209 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43264 ENERGY LEVELS OF ^{56}Mn. Van Assche, P. H. M. (Technical Univ., Munich. Research Establishment, Risoe, Denmark); Baader, H.; Koch, H. R.; Maier, B. P. K.; Gruber, U.; Schult, O. W. B.; Rimawi, K.; Chrien, R. E.; Wasson, O. A.; Garber, D. I.; McGrory, J. B. pp 210 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43265 LEVEL STRUCTURE OF ^{35}Cl FROM THE ^{34}Cl(p,p'γ)^{34}Cl REACTION. Taras, P.; Matas, J. (Univ., Montreal). pp 217 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43266 PROJECTED HF SPECTRA FOR ^{20}Ne AND ^{28}Si. Wong, S. K. M.; LeTourneux, L.; Quang-Hoc, N.; Saunier, G. (Univ., Montreal). pp 221 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43267 HARTREE–FOCK PROJECTED SPECTRUM FOR ^{24}Mg. Glen, J. A.; MacDonald, N. (Univ. of Glasgow). pp 222 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43268 THE ROLE OF SINGLE-PARTICLE ENERGIES IN McGrory, J. B. (Oak Ridge National Lab., Tenn.). pp 223 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43269 EFFECTS OF NON-CENTRAL FORCES IN ^{21}Ne. Wong, S. S. M. (Univ. of Toronto); Harvey, M. pp 226 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43270 TWO-PARTICLE TWO-HOLE ADMIXTURES IN 2s-1d SHELL NUCLEI. Padjen, R. (CEN, Saclay, France). pp 235 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43271 HARTREE–FOCK CALCULATION OF PROTON DISTRIBUTIONS IN ^{40}Ca AND ^{48}Ca. Lande, A.; Svenne, J. P. (Niels Bohr Inst., Copenhagen). pp 248 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43272 RESEARCH ON 2p-2h QUASI-BOUND ANALOG STATES IN THE GIANT RESONANCE OF ^{89}Y. Bergere, R.; Carlos, P.; Veyssiere, A.; Beil, H. (CEN, Saclay, France). pp 252 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43273 PROTON ELASTIC SCATTERING FROM ^{63}Cu AND ^{65}Cu AT 30 AND 50 MeV. Thomas, G. L.; Burge, E. J.; Smith, D. A. (King's Coll., London). pp 254 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43274 GROUND STATE CORRELATIONS IN ^{40}Ca. Seth, Kamal K. (Northwestern Univ., Evanston, Ill.); Picard, J.; Bassani, G. pp 257 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43275 THE ^{48}Ca(d,p)^{49}Ca REACTION. Bogaards, J. J. W.; Roy, G. (Univ. of Alberta, Edmonton). pp 258 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43276 STUDIES OF THE ^{21}Ne(d,p)^{22}Ne REACTION. Howard, A. J.; Pronko, J. G. (Yale Univ., New Haven). pp 259 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43277 STUDY OF SOME EXCITED STATES OF ^{21}Ne, ^{22}Ne, AND ^{23}Ne. Chambon, B.; Drain, D.; Yaker, M.; Dumaze, G.; Salmer, G.; Beaumevieille, H.; Lambert, M.; Nguyen Van Sen. pp 267 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43278 REACTIONS (p,d) ON ^{40}Ca AND ^{42}Ca. Buenerd, M.; Chabre, M.; Depommier, P.; Dupont, Y.; Martin, P. (Univ., Grenoble, France). pp 278 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43279 POLARIZATION EFFECTS IN THE ^{88}Sr(d,p)^{89}Sr REACTION INDUCED BY 12.3-MeV POLARIZED DEUTERONS. Griffith, J. A. R.; Irshad, M.; Karban, O.; Roman, S. (Univ. of Birmingham, Eng.). pp 280 of Contributions to the International Conference on Properties of Nuclear States, Montreal,

Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43280 LOW-LYING LEVEL STRUCTURE OF THE ^{33}S NUCLEUS INVESTIGATED BY THE ^{32}S(d,p) REACTION. Bobrowska, A.; Chyla, K.; Strzalkowski, A.; Tomza, U.; Wiktor, S. (Inst. of Nuclear Physics, Cracow, Poland). pp 283 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43281 SPIN FLIP IN INELASTIC SCATTERING. Geramb, H. V.; Amos, K. A. (Univ. of Georgia, Athens). pp 285 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43282 ^{21}Na LEVEL STRUCTURE NEAR 2.8 MeV EXCITATION. Pronko, J. G.; Lindgren, R. A.; Bromley, D. A. (Yale Univ., New Haven). pp 287 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43283 THE ^{58}Ni(p,α)^{55}Co AND THE ^{59}Co(p,α)^{56}Fe REACTION AT 41.3 MeV. Kost, C. J. (Indiana Univ., Bloomington); Li, T. Y.; Hird, B. pp 292 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43284 DEPENDENCE OF (d,α) CROSS SECTIONS ON THE COLLECTIVE STATES OF RESIDUAL NUCLEI IN THE SD SHELL. Hofmann, A.; Emmerich, W. D.; Philipp, G. (Univ., Erlangen, Ger.). pp 293 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43285 STUDY OF THE (d,α) REACTIONS ON ^{42}Ca AND ^{48}Ca AND THE SPINS OF THE LOW-LYING EXCITED STATES IN ^{46}K. Paul, M.; Marinov, A.; Drory, Ch.; Burde, J.; Havon, E.; Mordechai, Sh. (Hebrew Univ., Jerusalem). pp 294 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43286 RESONANCE STRENGTHS IN THE REACTION ^{27}Al(p,α)^{24}Mg. Harvey, P. J.; Sargood, D. G. (Univ. of Melbourne). pp 295 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43287 THE ^{37}Cl(p,t)^{35}Cl REACTION. Ball, G. C. (Chalk River Nuclear Labs., Ont.); Davies, W. G.; Ingebretsen, F.; Hird, B. pp 305 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43288 THE STRUCTURE OF THE EVEN NICKEL ISOTOPES FROM THE (p,t) REACTION. Davies, W. G. (Nuclear Physics Lab., Oxford); McLatchie, W.; Kitching, J. E.; Montague, D. G.; Ramavataram, K.; Chant, N. S. pp 306 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43289 THE ^{26}Mg(p,t)^{24}Mg REACTION AT 20 MeV. Fournier, R. (Univ. of Ottawa, Ont.); Kroon, J.; Hird, B.; Ball, G. C.; Ingebretsen, F.; Ollerhead, R. W. pp 307 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43290 ROTATIONAL BANDS IN ^{22}Ne. Scholz, W.; Neogy, P.; Bethge, K.; Middleton, R. (Univ. of Pennsylvania, Philadelphia). pp 311 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43291 MEASUREMENT OF THE TOTAL ^{48}Ca(p,n)^{48}Sc REACTION CROSS SECTION AROUND THE ISOBARIC ANALOG STATE AT E_p = 1.976 MeV. Sekharan, K. K.; Mehta, M. K. (Bhabha Atomic Research Center, Bombay). pp 318 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43292 THE CHARACTER OF THE 5.387- AND 6.095-MeV STATES IN ^{49}Ca STUDIED VIA THEIR ISOBARIC ANALOG STATES IN ^{49}Sc. Benin, R.; Marinov, A.; Drory, Ch.; Burde, J.; Engler, G. (Hebrew Univ., Jerusalem). pp 322 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43293 THE LOWEST T = $\frac{3}{2}$ STATE IN ^{33}Cl. Spitz, L. M.; Brooks, F. D. (Univ. of Cape Town, S. Afr.). pp 324 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43294 CORE COUPLED RESONANCES IN THE ^{86}Kr PLUS p REACTION. Riley, P. J.; Hollas, C. L.; Hiddleston, H. R.; Mistry, V. D. (Univ. of Texas, Austin). pp 326 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43295 THE ENERGY SPECTRUM OF ^{40}Ca REVISITED. Federman, P.; Pittel, S. (Franklin Inst., Swarthmore, Pa.). pp 333 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43296 SIX-QUASIPARTICLE O^+ STATES IN NICKEL AND TIN ISOTOPES AND IN THE N = 50 ISOTOPES. Jaffrin, A. (CEN, Saclay, France). pp 340 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French)
See CONF-690804.

43297 PAIRING VIBRATIONAL STATES OF Ca ISOTOPES. Akiyama, Y. (Univ. of Michigan, Ann Arbor); Soga, M. pp 345 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43298 MEASUREMENTS ON THE VIBRATIONAL SPLITTING OF THE GIANT DIPOLE RESONANCE. Owen, D. G.; Muirhead, E. G.; Spicer, B. M. (Univ. of Melbourne). pp 349 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43299 THE ^{39}K PHOTONEUTRON CROSS SECTION TO THE ISOMERIC STATE OF ^{38}K. Webb, D. V.; Muirhead, E. G.; Spicer, B. M. (Univ. of Melbourne). pp 351 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43300 INTERMEDIATE STRUCTURE IN ^{39}K + p → ^{40}Ca STUDIES. Legge, G. J. F. (Univ. of Pennsylvania, Philadelphia. Univ. of Melbourne); Krick, M. S. pp 360 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43301 EFFECTIVE INTERACTION FOR α-PARTICLE SCATTERING. Jackson, Daphne F. (Univ. of Surrey, Guildford, Eng.); Morgan, C. G. pp 361 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43302 SIMPLE CONTINUUM STATES OF ^{41}Sc: THEIR FORMATION AND DECAY. Tang, J. C. N.; Legge, G. J. F. (Univ. of Melbourne). pp 362 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43303 THE NEUTRON CAPTURE WIDTH OF THE 132-eV ^{59}Co RESONANCE. Stroud, D. B. (Univ. of Melbourne); Wall, T. pp 365 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43304 HIGH-RESOLUTION TOTAL NEUTRON CROSS SECTION IN VANADIUM. Garg, J. B. (State Univ. of New York, Albany); Rainwater, J.; Havens, W. W. Jr. pp 367 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43305 EVIDENCE FOR CHANNEL RESONANCE CAPTURE IN ^{55}Mn(n,γ)^{56}Mn. Rimawi, K. (State Univ. of New York, Albany); Wasson, O. A.; Chrien, R. E.; Garber, D. I. pp 368 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43306 ELASTIC SCATTERING OF 40-MeV α PARTICLES ON ^{58}Ni, ^{64}Ni, ^{64}Zn, ^{68}Zn. Gonchar, V. Yu.; Zheltonog, K. S.; Ivanov, G. N.; Yushkov, A. V. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat., No. 6, 16-24(Nov.-Dec. 1968). (In Russian).
The angular distributions of α particles elastically scattered by ^{58}Ni, ^{64}Ni, ^{64}Zn, and ^{68}Zn at 40 MeV were measured in the 18 to 80° interval. Attention was given to duplicating the conditions for all the isotopes in order to increase the relative accuracy of the measurements. A phase shift analysis of the data was performed using an automatic search code. (J.W.R.)

43307 EXTENDED ANALYSIS OF ^{40}Ca(α,α_0)^{40}Ca SCATTERING AND A ^{20}Ne(α,α')^{20}Ne SCATTERING EXPERIMENT AND ANALYSIS. Bisson, Arthur Edward. Tallahassee; Florida State Univ. (1969). 156p.
Thesis.
The thin target fine energy resolution data measured previously by P. Robinson and J. John were used to test the range of applicability and necessary modifications needed in present nuclear models in order to obtain satisfactory fits to the energy averaged angular distributions of alpha particles elastically scattered by ^{40}Ca. It was found that an incoherent sum of cross sections obtained from a modified optical model plus cross sections obtained by a Hauser–Feshbach term produced satisfactory fits to the energy averaged angular distributions over the full bombarding energy range of 5.5 to 17.5 MeV. It was necessary to include an l-dependent absorption in the standard optical model in order to reproduce the back angle enhancement of the experimental cross section seen in the alpha particle scattering by ^{40}Ca. The Hauser–Feshbach parameters ρ and σ obtained in fitting the energy averaged data were not only extra fitting parameters but were found to be consistent with calculations based on the superconductor model and Fermi gas model. The alpha particle scattering by the strongly deformed nucleus ^{20}Ne was studied. In this experiment 48 point angular distributions were measured every 20 keV in the bombarding energy range of 11.70 keV to 13.78 MeV. The experimental cross sections corresponding to the ground state and first two excited states of ^{20}Ne were energy averaged over an energy interval of 1.56, 1.0 and 1.0 MeV, respectively. It was not possible to obtain a satisfactory fit to the energy averaged angular distribution corresponding to the ground state of ^{20}Ne with the spherical optical model plus Hauser–Feshbach term. Assuming a rotational coupling between the ground and first two excited states of ^{20}Ne it was possible to obtain a good simultaneous fit to the 0^+, 2^+ and 4^+ states by an incoherent sum of cross sections calculated from a coupled channel analysis plus cross sections calculated by a Hauser–Feshbach term. The deformation parameters obtained from the coupled channel analysis are consistent with those obtained in previous analyses. (Diss. Abstr. Int., B)

43308 γ-RAY SPECTRUM FROM REACTION ^{74}Se(n,γ)^{75}Se ON THERMAL NEUTRONS. Rudak, E. A.; Firsov, E. I.; Khil'manovich, A. M. (Inst. of Physics, Minsk). Yadern. Fiz.; 11: 1129-32(Jun 1970). (In Russian).
The γ-ray spectrum from the reaction ^{74}Se(n,γ)^{75}Se with thermal neutrons was studied using the 2% resolution magnetic Compton spectrometer on the reactor IRT of the Academy of Sciences of Belorussian SSR. The scheme of γ transitions of ^{75}Se nucleus from initial state in the (n,γ) reactions is proposed. (auth)

43309 . NUCLEAR DATA SHEETS. Nucl. Data, Sect. B, 3: B.3.5,6.1-217(Apr 1970).
Energy level systematics and decay characteristics for A = 50 through 54 nuclei, compiled from the available experimental data, are presented. Inconsistencies and discrepancies in the data are discussed, and comparisons with theory are given. (J.W.R.)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 41532, 41533, 43104, 43105, 43117, 43119, 43122, 43123, 43172, 43183, 43203, 43213, 43217, 43225, 43227, 43248, 43296, and 43526.

43310 (AI-AEC-Memo-12916) AN EVALUATION OF ^{235}U NEUTRON CROSS SECTION DATA FOR ENERGIES ABOVE 15 keV. Alter, H.; Dunford, C. L. (Atomics International, Canoga Park, Calif.). 20 Jan 1970. Contract AT(04-3)-701. 20p. Dep. CFSTI.
The neutron cross section data for uranium-235 in the energy range 15 keV to 15 MeV were reevaluated. This task was performed in support of the special working group effort directed by the National Neutron Cross Section Center. The need for reevaluating and updating the fissile/fertile nuclide cross section data sets originally prepared for the ENDF/B library was established by the results of Phase II data testing. (auth)

43311 (CALT-63-121) EXPERIMENTS ON PARITY NONCONSERVATION IN NUCLEAR FORCES. Vanderleeden, J. C.; Boehm, F. (California Inst. of Tech., Pasadena). [1969]. Contract AT(04-3)-63. 24p. (CONF-690958-1). Dep. CFSTI.
From Conference on Nuclear and Elementary Particle Physics, Brighton, England.
The circular polarization of gamma rays from unpolarized sources of ^{181}Hf and ^{175}Yb was measured, using a Compton polarimeter and a current-integrating Ge(Li) detector system. The results are $P_\gamma = (-3.8 \pm 1.3) \times 10^{-6}$ for the 482-keV transition in ^{181}Ta and $P_\gamma = (+6.2 \pm 0.8) \times 10^{-6}$ for the 396-keV transition in ^{175}Lu. (auth)

43312 (CONF-700101-(Vol.2), pp 1306-14) SYMMETRY OF NEUTRON-INDUCED ^{235}U FISSION AT INDIVIDUAL RESONANCES. III. Cowan, G. A.; Bayhurst, B. P.; Prestwood, R. J.; Gilmore, J. S.; Knobeloch, G. W. (Los Alamos Scientific Lab., N. Mex.).
From Symposium on engineering with nuclear explosives, Las Vegas, Nevada, January 14-16, 1970. Proceedings.
A "wheel" experiment, using an underground nuclear explosion as a neutron source, was employed to study the symmetry of ^{235}U fission at individual resonances. The yield ratio 2.3-day ^{115}Cd to 2.7-day ^{99}Mo was measured at 38 well-resolved resonances between 20 and 60 eV. The frequency distribution of the yield ratio indicates two troups of resonances for which spins of J = 3 and J = 4 are most probable. (J.W.R.)

43313 (COO-1505-42) DEEXCITATION PROCESSES IN NUCLEAR REACTIONS. Progress Report, May 1969–April 1970. Porile, Norbert T. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). May 1970. Contract AT(11-1)-1505. 39p. Dep. CFSTI.
COPPER-65 — alpha reactions (α,αn) at 20 to 42 MeV, differential range study of reaction mechanism in, (E)
— helium-3 reactions (He-3,α) at 32 MeV, differential range study of reaction mechanism in, (E)
URANIUM-238 — proton reactions at 0.45 to 11.5 GeV, energy dependence of recoil properties of products from, (E)
VAN DE GRAAFF ACCELERATORS — experimental facilities at Purdue University, for nuclear chemistry research. (J.W.R.)

43314 (FOA-4-4420-28) STUDIES OF MIXED FISSION PRODUCTS FROM THERMAL FISSION OF ^{235}U WITH A Ge(Li) DETECTOR. De Geer, L. E. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Apr 1970. 19p. (In Swedish). Dep. CFSTI (U. S. Sales Only).
Gamma spectra from fission products of reactor-irradiated ^{235}U were recorded with a 7.2-cm^3 crystal and analyzed by a 1600-channel analyzer. The Ge(Li) detector was shown to be superior to the NaI detector for analysis of complicated spectra. A data table is presented with the counting rate for every known actual photopeak. The purpose of the work was to create tools for the analysis of fallout from nuclear explosions. (Sweden)

43315 (INR-1175) INVESTIGATION OF THE (n, α) REACTIONS INDUCED BY 14.2-MeV NEUTRONS IN ERBIUM ISOTOPES. Jaskola, M.; Osakiewicz, W; Rogulski, Z; Turkiewicz, J.; Zemlo, L. (Institute of Nuclear Research, Warsaw (Poland)). 1970 12p. Dep. CFSTI (U.S. Sales Only).

The energy spectra of alpha particles from $^{166}Er(n, \alpha)^{163}Dy$ and $^{168}Er(n, \alpha)^{165}Dy$ reactions at 14.2 MeV were studied using the semiconductor detector technique. The analysis of the spectra leads to the conclusion that the evaporation theory is inadequate for the description of the reactions and that direct effects with the strong excitation of single neutron levels in the final nucleus are present. (auth)

43316 (LA-4420) FISSION CROSS SECTIONS FROM POMMARD. Seeger, P. A. (Los Alamos Scientific Lab., N. Mex.). 8 Apr 1970. Contract W-7405-eng-36. 159p. Dep. CFSTI.

Neutron-induced fission cross sections measured by Los Alamos Scientific Laboratory Groups P-3 and W-8 on the Pommard event of March 15, 1968, are plotted and given in numerical tables. The isotopes ^{232}U, ^{233}U, ^{235}U, ^{236}U, ^{237}U, ^{238}Pu, ^{242}Pu, ^{243}Am, and ^{243}Cm are included. The names of the authors to be referenced are given with each isotope. This report is not to be used as a reference without the permission of the individual workers. (auth)

43317 (LYCEN-7029) EXCITED ^{141}Ne LEVELS RESULTING FROM THE DECAY OF ^{141}Pm ISOTOPE WITH A HALF-LIFE OF 21 MINUTES. Charvet, A.; Duffait, R.; Emsallem, A.; Chery, R. (Lyon Univ. (France). Institut de Physique Nucleaire). May 1970. 18p. (In French). Dep. CFSTI (U. S. Sales Only).

The decay of ^{141}Pm ($T_{\frac{1}{2}}$ = 21 min) was studied with Ge(Li) and Si(Li) detectors. The following measurements were made: the energies and intensities of the γ rays, the γ, γ coincidence spectra, and the spectral sum obtained with a Ge(Li) detector of 4π geometry. The results indicate the following energies (in keV): 193.7 keV ($\frac{1}{2}^+$); 1223.3 ($\frac{5}{2}^+$); 1345.4 ($\frac{5}{2}^-$, $\frac{7}{2}^-$); 1564.7 (?); 1596.9 ($\frac{3}{2}^+$, $\frac{5}{2}^+$); 1820.2; 1897.0; 1967.4 ($\frac{7}{2}^+$); 2073.5 ($\frac{3}{2}^+$, $\frac{5}{2}^+$); 2109.8 ($\frac{5}{2}^+$, $\frac{7}{2}^+$) and 2247. The decay scheme accounts for 19 of the 24 transitions observed in the present work. The half-life of the first excited levels was found to be $(1.17 \pm 0.15)\ 10^{-9}$ seconds. The Q-value of the decay $^{141}Pm \rightarrow {}^{141}Nd$ was determined to be 3730 ± 40 keV. The nature of excited states of ^{141}Nd are discussed in terms of current nuclear models. (France)

43318 (UCRL-18633) THE BERKELEY HILAC HEAVIEST ELEMENT RESEARCH PROGRAM. Ghiorso, Albert (California Univ., Berkeley. Lawrence Radiation Lab.). Apr 1970. Contract W-7405-eng-48. 62p. (CONF-691124-1). Dep. CFSTI.

From Robert A. Welch Foundation Conferences on Chemical Research. XIII. The Transuranium Elements, Houston, Tex.

Recent work on element 104 at the Berkeley HILAC is described. The alpha-decay properties of the isotopes $^{257}104$, $^{259}104$, and $^{261}104$ were established, and the spontaneously-fissioning isotope, $^{258}104$, was tentatively characterized. Element 104 was chemically separated by an aqueous method and shown to have properties like hafnium and zirconium as expected. A spontaneous fission activity of element 104 with a 0.3 second half-life as reported by the Dubna group could not be found. (J.W.R.)

43319 (UCRL-50881) AN ATTEMPT TO ASSIGN NEUTRON RESONANCE SPINS IN ^{235}U BY CAPTURE GAMMA RAY MULTIPLICITY MEASUREMENTS. Bowman, C. D.; Berman, B. L.; Sauter, G. D. (California Univ., Livermore. Lawrence Radiation Lab.). 25 May 1970. 8p. Dep. CFSTI.

An attempt has been made to assign neutron resonance spins in ^{235}U by means of the multiplicity of radiative capture γ rays. The expected grouping of resonances according to spin was not observed, so spin assignments were not possible. Arguments against further attempts at measurement of the spin by indirect techniques are presented. (auth)

43320 ELECTRIC HEXADECAPOLE TRANSITION MOMENT IN ^{152}Sm. Stephens, F. S. (Univ. of California, Berkeley); Diamond, R. M.; Glendenning, N. K.; de Boer, J. Phys. Rev. Lett.; 24: 1137-41(18 May 1970).

The Coulomb excitation of the 4^+ rotational state of a deformed nucleus can proceed by both double E2 and single E4 transitions. The excitation cross section also contains a term corresponding to the interference between the two. The Coulomb excitation of ^{152}Sm with ^4He projectiles is carefully measured and the results are analyzed with a computer program including E4 terms. Best fits were obtained for $\langle 0^+ \| \mathcal{M}(E4) \| 4^+ \rangle = (+0.35 \pm 0.11)e\ b^2$. (auth)

43321 MEASUREMENT OF THE FISSION CROSS SECTIONS OF ^{239}Pu AND ^{233}U RELATIVE TO ^{235}U. Pfletschinger, E.; Kaeppeler, F. (Institut fuer Angewandte Kernphysik, Karlsruhe, Ger.). Nucl. Sci. Eng.; 40: 375-82(Jun 1970).

The fission cross-section ratios $^{239}Pu-{}^{235}U$, $^{233}U:{}^{235}U$ are measured as a function of neutron energy between 5 keV and 1 MeV with an accuracy between 1.5 and 3%. Fission events are detected in 4 π-geometry by means of argon-filled gas scintillation chambers. The neutron energy is determined by the time-of-flight technique. The results are compared with the evaluations of Davey. For the ratio $^{239}Pu:{}^{235}U$ there is fairly good agreement between the measured values and the evaluation of Davey, except in the energy region between 200 and 800 keV. There, our values are ~2 to 4% lower than those of Davey. The $^{233}U:{}^{235}U$ ratio agrees with Davey's curve for neutron energies <60 keV. Above this energy, our results are ~5% higher than the evaluated curve of Davey. (auth)

43322 MEASUREMENT OF THE RATIOS OF CAPTURE AND FISSION NEUTRON CROSS SECTIONS OF ^{235}U, ^{238}U, AND ^{239}Pu AT 130 TO 1400 keV. Poenitz, W. P. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 40: 383-8(Jun 1970).

The ratios $\sigma_\gamma(^{238}U)/\sigma_f(^{235}U)$, $\sigma_\gamma(^{238}U)/\sigma_f(^{239}Pu)$, and $\sigma_f(^{239}Pu)/\sigma_f(^{235}U)$ are measured in the energy range 130 to 1400 keV. The activation technique is used to determine the capture rate in ^{238}U. The 278 keV γ ray emitted in the decay of ^{239}Np is detected by means of a Ge(Li) detector. The counting efficiencies are absolutely determined for the measurement of $\sigma_\gamma(^{238}U)/\sigma_f(^{239}Pu)$. For the determination of the ratio $\sigma_\gamma(^{238}U)/\sigma_f(^{235}U)$ the counting efficiencies are eliminated by a measurement of the ratio at thermal-neutron energies. The ratio $\sigma_f(^{239}Pu)/\sigma_f(^{235}U)$ is measured in a back-to-back gas scintillation counter using the time-of-flight method for background suppression. The measurements resulted in an overdetermination of two unknown quantities by three measured values. The fitted values derived from the collective results are in good agreement with the individual measured ratios. (auth)

43323 TOTAL NEUTRON CROSS SECTION OF ^{242}Pu. Young, T. E.; Reeder, S. D. (Idaho Nuclear Corp., Idaho Falls). Nucl. Sci. Eng.; 40: 389-95(Jun 1970).

The total neutron cross section of ^{242}Pu is measured from 0.0015 to 8000 eV, using PuO_2 powder samples in the Materials Testing Reactor (MTR) fast chopper. The data give 26.9 ± 2.0 and 18.5 ± 2.0 b for the 0.0253 eV total and absorption cross sections, respectively. It is necessary to correct the total cross-section data for water contamination and for the effect of scattering by small particles. To determine the proper forms for these corrections, low-energy total cross-section measurements are made using samples of Al_2O_3 and ThO_2. Analysis of resonances below 180 eV gives a resonance absorption integral of 1110 ± 60 b, and a neutron s-wave strength function ($\overline{\Gamma}_n^0/D$) of $(0.99 \pm 0.44) \times 10^{-4}$. (A weighted average of data available on this isotope gives 1175 ± 70 b for the resonance absorption integral and 19.7 ± 1.0 b for the neutron absorption cross section at 0.0253 eV.) (auth)

43324 BETA-GAMMA DIRECTIONAL CORRELATION MEASUREMENTS INVOLVING FIRST-FORBIDDEN BETA TRANSITIONS IN THE DECAY OF ^{124}Sb AND ^{160}Tb. Cipolla, Sam Joseph. Lafayette, Ind;, Purdue Univ. (1969). 226p.

Thesis.

Beta-Gamma Directional Correlations involving the first-forbidden β transitions of W_0 = 1.590 MeV and W_0 = 1.667 MeV in the decay of ^{124}Sb to the two-phonon excited levels of ^{124}Te were investigated using a spectrometer composed of a Ge(Li) γ detector and a scintillation β detector. The 1.590 MeV β transition showed a very anisotropic directional correlation with a prominent energy dependence, while the directional correlation of the 1.667 MeV β transition was much less anisotropic and its small anisotropy seemed to be independent of energy. Beta-Gamma directional correlation measurements of the cascades $\beta(1.750)$-$\gamma(0.087)$ and $\beta(1.540)$-$\gamma(0.197)$ in the decay of the deformed nucleus ^{160}Tb to ^{160}Dy were performed with the same instrument for the purpose of testing the predictions of the K-selection rule. The results for the $\beta(1.750)$-$\gamma(0.087)$ directional correlation can be interpreted to show that $\int iB_{ij}$ is enhanced, which is in agreement with nuclear model expectations. However, the analysis of the $\beta(1.540)$-$\gamma(0.197)$ directional correlation measurement was not successful, and speculations are presented to explain this result. (Diss. Abstr.)

43325 NEUTRON RESONANCE PARAMETERS AND RADIATIVE CAPTURE CROSS SECTION OF Gd FROM 3 eV TO 750 keV. Friesenhahn, S. J.; Fricke, M. P.; Costello, D. G.; Lopez, W. M.; Carlson, A. D. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Phys.; A146: 337-58(1970).

Resonance parameters for neutron energies from 3 eV to 200 eV and average capture cross sections for energies up to 20 keV have been measured for the separated isotopes ^{155}Gd and ^{157}Gd with neutron time-of-flight techniques and a large liquid scintillator. In addition, the average capture cross section of natural gadolinium was measured from 1 keV to 750 keV. The s-wave strength func-

tions obtained are $2.17^{+0.30}_{-0.14} \times 10^{-4}$ for ^{155}Gd and $2.9^{+0.9}_{-0.5} \times 10^{-4}$ for ^{157}Gd, and these values are significantly higher than those predicted from the collective-model generalization of the optical model. The total radiation widths for resolved resonances are found to have a much larger variance than that predicted by the statistical model, provided the widths are assumed to be spin-independent. The average capture cross section at higher energies is also found to deviate from conventional statistical-model predictions. (auth)

43326 ISOSPIN FORBIDDEN RESONANCES IN THE REACTION ^{93}Nb(p,α)^{90}Zr. Cue, Nelson; Polsky, Lawrence M.; Worth, Donald C. (State Univ. of New York, Stony Brook). Phys. Rev. Lett.; 25: 453-6(17 Aug 1970).

Isospin forbidden resonances ($\Delta T = 1$) have been observed in the reaction ^{93}Nb(p,α)^{90}Zr. Angular distributions to the 0^+ ground state measured at the 4^+ (59-keV) and 2^+ (334-keV) analog resonances indicate that the 2^+ isospin analog state is formed via a pure $d_{\frac{5}{2}}$ capture whereas the 4^+ isospin analog state is formed by a coherent admixture of $d_{\frac{5}{2}}$, $s_{\frac{1}{2}}$, and $d_{\frac{3}{2}}$ components. (auth)

43327 (n,α) REACTIONS ON HEAVY NUCLEI INDUCED BY 15.1 MeV NEUTRONS. Kitazawa, Hideo (Tokyo Inst. of Tech.). Nucl. Phys.; A149: 513-17(1970).

The energy spectra of α-particles from the (n,α) reactions on ^{141}Pr, ^{165}Ho, ^{175}Lu, ^{181}Ta, and ^{197}Au induced by 15.1-MeV neutrons at 0° have been measured with a n-type silicon surface barrier semiconductor. They cannot be accounted for by the statistical model, with the inclusion of the shell effect for the level density, which is derived from the free gas model for a two-fermion system. The angular distribution of α-particles from ^{141}Pr is strongly forward-peaked. It seems that there is an appreciable contribution of direct processes to these reactions. (auth)

43328 THE α DISINTEGRATION OF ^{224}Ac. Briand, Jean-Pierre; Chevallier, Pierre (Paris Univ.). Compt. Rend., Ser. B; 271: 58-60(6 Jul 1970). (In French).

The energy levels of ^{220}Fr excited in the α disintegration of ^{224}Ac are studied by (α,γ) and (α,e^-) coincidence techniques using solid-state detectors. From these experiments the multipolarity of the γ transitions and the spin and parity of the excited ^{220}Fr levels are deduced. (France)

43329 TOTAL NEUTRON CROSS SECTION OF ^{99}Tc FROM 0.01 TO 1000 eV. Watanabe, T.; Reeder, S. D. (Idaho Nuclear Corp., Idaho Falls). Nucl. Sci. Eng.; 41: 188-92(Aug 1970).

The neutron transmission of ^{99}Tc for neutron energies less than 1 keV has been measured with the Material Testing Reactor (MTR) fast chopper with a resolution of 0.04 to 1.8 μsec/meter. A total neutron cross section at 0.0253 eV of 24.7 ± 1.7 b was obtained. To fit the cross-section data in the thermal energy range, it was necessary to assume a contribution by a bound level together with contributions from measured resonances at positive energies. Resonance parameters are presented for levels observed in the energy region from 0.01 to 300 eV. Two additional resonances, not listed in the literature, have been measured and analyzed. Parameters of individual resonances below 300 eV and average parameters at higher energies give a resonance absorption integral of 340 ± 20 b, and a value of (0.43 ± 0.14) × 10^{-4} for the s-wave neutron strength function. (auth)

43330 SLOW NEUTRON FISSION CROSS-SECTION OF ^{237}Np. Gavrilov, K. A.; Koshaeva, K. K.; Kraitor, S. N.; Pikel'ner, L. B. At. Energ. (USSR); 28: 362-5(Apr 1970). (In Russian).

Fission cross sections of ^{237}Np were measured with neutrons having energies from 0.01 to 1000 eV. A time-of-flight method was used on a pulse reactor with fission fragments of ^{237}Np being counted on a ZnS scintillation detector. Special measurements were undertaken to be sure that no ^{239}Pu or ^{235}U impurities were present in the ^{237}Np target. Sharp maxima in the fission cross sections were observed at neutron energies of 40, 120, 205, and 250 eV. The fission widths are tabulated for the ^{237}Np resonances. ^{237}Np can be used as a threshold detector at neutron energies above 0.7 MeV only by cladding with boron. At low neutron energies, additional fissions take place to give anomalous results in the presence of soft neutrons. (TTT)

43331 SPONTANEOUS FISSION HALF-LIFE OF ^{252}Cf. Aleksandrov, B. M.; Bak, M. A.; Bogdanov, V. G.; Bugorkov, S. S.; Drapchinskii, L. V.; Solov'eva, Z. L.; Sorokina, A. V. At. Energ. (USSR); 28: 361-2(Apr 1970). (In Russian).

The spontaneous fission half-life of ^{252}Cf is determined by the half-life of ^{252}Cf and the ratio of the number of alpha decays to the number of fission events. ^{252}Cf was deposited electrolytically on a backing of titanium. The alpha-to-fission ratio was found to be 32 ± 0.3 in measurements with an ionization chamber at 2π geometry, and 31.5 ± 0.3 in measurements with a semiconductor detector. Measurements of alpha and fission particle tracks in a nuclear emulsion pile gave a value of 31.1 ± 0.5 for this ratio. On taking a value of 7.212 ± 0.017 × 10^{-4} day^{-1} for the decay constant, and a value of 31.34 ± 0.08 for the alpha-to-fission ratio, a value of 2.227 ± 0.011 × 10^{-5} day^{-1} is obtained for the spontaneous fission decay constant which corresponds to a spontaneous fission half-life of 85.2 ± 0.4 yr for ^{252}Cf. (TTT)

43332 RESONANCE FISSION INTEGRALS OF ISOTOPES OF URANIUM, PLUTONIUM, AND AMERICIUM. Bak, M. A.; Petrzhak, K. A.; Petrov, Yu. G.; Romanov, Yu. F.; Shlyamin, E. A. At. Energ. (USSR); 28: 359-60(Apr 1970). (In Russian).

Ratios of resonance fission integrals were measured on ^{233}U, ^{235}U, ^{239}Pu, ^{241}Pu, and ^{241}Am. A layer of fissionable material was deposited electrolytically on platinum foil. The amount of fissionable material was determined by alpha counting with the isotopic composition of the sample being taken into account. The target was placed in a double ionization chamber which could be shielded on all sides with 1 mm of cadmium. The values of the resonance integrals were found to be 850 barns for ^{233}U, 274 barns for ^{235}U, 330 barns of ^{239}Pu, 550 barns for ^{241}Pu, and 21 barns for ^{241}Am which agreed well with values of 761, 277, 324, and 541 barns for the first four isotopes as given in the literature. (TTT)

43333 HALF-LIFE OF THE 89.83 keV LEVEL IN ^{152}Eu. Gerl, A.; Loebner, K. E. G. (Technische Hochschule, Munich). Z. Phys.; 235: 263-4(1970).

The half-life of the 89.83-keV level in ^{152}Eu was measured in the ^{151}Eu(n,γ)^{152}Eu reaction to be 381 ± 19 nsec. This results in the determination of the absolute transition probabilities of the 89.83 keV E1 + M2 transition to the ground state, yielding hindrance factors relative to the Weisskopf estimate $F_W(E1) = (2.3 \pm 0.4) \times 10^6$ and $F_W = 0.20 \pm 0.08$. (auth)

43334 ANALYSIS OF FAST NEUTRON ELASTIC SCATTERING FROM TANTALUM USING A NON-SPHERICAL OPTICAL POTENTIAL. Holmqvist, B. (Neutron Physics Lab., Nykoeping, Sweden); Wiedling, T.; Benzi, V.; Zuffi, L. Nucl. Phys.; A150: 105-13(1970).

The angular distributions of neutrons elastically scattered from the deformed nucleus ^{181}Ta were measured between 2.5 and 8.0 MeV. The results were compared with optical-model calculations using both a spherical and a non-spherical potential. The angular distributions calculated with a non-spherical potential fit the experiments better than those calculated with a spherical potential. (auth)

43335 LIFETIME MEASUREMENT OF THE FIRST EXCITED STATE IN ^{206}Pb. Quebert, J. L.; Nakai, K.; Diamond, R. M.; Stephens, F. S. (Univ. of California, Berkeley). Nucl. Phys.; A150: 68-74(1970).

The first excited state of ^{206}Pb (2^+, 803 keV) was produced by Coulomb excitation using 170 MeV ^{40}Ar projectiles, and the mean life of this state was determined by the recoil-distance Doppler-shift method to be: $\tau = 13.2 \pm 0.8$ ps. (auth)

43336 LEVEL SCHEME OF ^{198}Au FROM γ-γ-COINCIDENCE MEASUREMENTS. Loebner, K. E. G.; Kloeckner, J.; Schimmer, H.; Kienle, P. (Technische Hochschule, Munich). Z. Phys.; 235: 254-62(1970).

Prompt and delayed low-energy $\gamma-\gamma$ coincidences from the ^{197}Au(n,γ)^{198}Au reaction have been measured with Ge(Li) and NaI(Tl) detectors at the external neutron beam of the research reactor (FRM) near Munich. A level scheme consistent with all available experimental data is constructed and discussed. The half-life of the 367.29 keV level was obtained with a time-to-amplitude converter to be 123 ± 4 ns. It determines the absolute transition probability of the 97.211-keV E1 transition. (auth)

43337 ELECTRON-CAPTURE DECAY OF ^{191}Pt. Schmidt-Ott, W.-D. (Univ., Goettingen, Ger.). Z. Phys.; 236: 445-51 (1970). (In German).

The relative probability for K-capture $PK_{939}/PK_{539} \leq 0.05$ and for L-capture $PL_{939}/PL_{539} = 4.4 \pm 0.7$ yield a total transition energy Q_{EC} in the energy interval $981 \leq Q_{EC} \leq 1{,}021$ keV. The high-energy γ-spectrum and the half-life of ^{191}Pt were remeasured. (auth)

43338 SEARCH FOR E0 TRANSITIONS IN ^{208}Pb BY NEUTRON-CAPTURE CONVERSION ELECTRONS. von Egidy, T.; Mampe, W.; Olma, B.; Kaiser, W. (Technische Hochschule, Munich). Z. Phys.; 236: 440-4(1970).

The neutron-capture conversion-electron spectrum of the ^{207}Pb (n, e)^{208}Pb reaction has been measured between 2 and 7.5 MeV. Only the weak K-line from the 7,368 keV transition has been observed. The upper intensity limits for conversion electron lines have been estimated to be 5×10^{-4} per capture between 4 and 5 MeV. A graph shows the ratio of internal pair formation to internal K conversion for E0-transitions. (auth)

43339 INTERNAL K-CONVERSION COEFFICIENTS OF TRANSITIONS IN ^{182}W. El-Farrash, A. H.; Abdel Hamid, M. G. (Atomic Energy Establishment, Cairo). Z. Phys.; 236: 417-23(1970).

The K-conversion coefficients of seven low-energy transitions (~ 100 to 400 keV) in ^{182}W following the decay of ^{182}Ta have been determined by the NPG method using the newly reported γ-ray intensities measured by Ge(Li) detectors. The results are compared with theoretical values deduced from the tabulations of Rose, Sliv and Band, and Pauli. The weak peak corresponding to the K-conversion line of the 351.3-keV transition could be observed in accordance with the previous investigations; however, the existence of the previously reported 146.3-keV transition could not be confirmed. Also, the K-conversion line of the recently reported 1104.4-keV transition could not be observed. (auth)

43340 BRANCHING RATIOS OF E1 TRANSITIONS IN ^{173}Yb. Kurcewicz, W.; Preibisz, Z.; Stryczniewicz, K.; Zylicz, J. (Inst. of Nuclear Research, Swierk, Poland). Acta Phys. Pol.; A38: 123-6(1970).

Branching ratios of E1 transitions between the $^{7}/_{2}^{+}$ [633] and $^{5}/_{2}^{-}$ [512] rotational bands in ^{173}Yb were established. The drastic disagreement of these ratios with the predictions of the Alaga rule is essentially diminished if the Michailov formula is applied. (auth)

43341 HIGH RESOLUTION GAMMA SPECTROSCOPY IN ^{227}Ac. de Pinho, A. G.; da Silveira, E. F., da Costa, N. L. (Instituto de Fisica, Rio de Janeiro). pp 2 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43342 HALF-LIVES OF ROTATIONAL LEVELS IN ^{152}Sm. Diamond, R. M.; Stephens, F. S.; Nordhagen, R.; Nakai, K. (Univ. of California, Berkeley). pp 7 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43343 NUCLEAR STRUCTURE STUDIES ON ^{96}Mo USING THERMAL NEUTRON CAPTURE IN ^{95}Mo. Heck, D.; Michaelis, W.; Ottmar, H.; Schmidt, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 8 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43344 EXPERIMENTAL AND THEORETICAL STUDIES OF CONFIGURATION MIXING IN RARE-EARTH NUCLEI. Michaelis, W.; Weller, F.; Fanger, U.; Gaeta, R.; Ottmar, H.; Schmidt, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 9 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43345 CALCULATION OF K-FORBIDDEN GAMMA-RAY TRANSITION PROBABILITIES IN ODD-MASS RARE-EARTH NUCLEI. Weller, F.; Markus, G. (Kernforschungszentrum, Karlsruhe, Ger.). pp 10 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43346 E2 MATRIX ELEMENTS FROM BETA VIBRATIONAL STATES. Fraser, I. A.; Greenberg, J. S.; Sie, S. H.; Stokstad, R. G.; Bromley, D. A. (Yale Univ., New Haven). Contract AT(30-1)-3223. pp 13 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43347 THE EFFECTS OF BAND MIXING ON TRANSITION MATRIX ELEMENTS IN THE GROUND STATE BANDS OF ^{152}Sm AND ^{154}Sm. Fraser, I. A.; Greenberg, J. S.; Sie, S. H.; Stokstad, R. G.; Bromley, D. A.; Wright, A. W. (Yale Univ., New Haven). Contract AT(30-1)-3223. pp 14 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43348 EXCITED LEVELS OF ^{186}W OBSERVED IN THE β^- DECAY OF ^{186}Ta → ^{186}W. Monnand, E.; Blachot, J.; Moussa, A. (CEN, Grenoble, France). pp 16 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43349 GAMMA TRANSITIONS FROM HIGH SPIN STATES IN THE BETA-VIBRATIONAL BAND OF ^{154}Gd. Ferguson, S. M.; Ejiri, H. (Univ. of Wash., Seattle). pp 17 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43350 γ– γ ANGULAR CORRELATION MEASUREMENTS IN ^{185}Re. Badica, T.; Gelberg, A.; Salageanu, S. (Inst. for Atomic Physics, Bucharest). pp 18 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43351 DIRECTIONAL CORRELATION MEASUREMENTS ON γ-RAY CASCADES IN ^{170}Yb. Paperiello, C. J.; Funk, E. G.; Mihelich, J. W.; Schilling, G. (Univ. of Notre Dame, Ind.). pp 20 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43352 HALF-LIFE MEASUREMENTS IN ^{235}U. Hoejeberg, M. (Univ. of Stockholm); Malmskog, S. G. pp 21 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43353 DECAY OF 16-SEC ^{100}Tc. Bunker, M. E.; Berzins, G.; Starner, J. W. (Los Alamos Scientific Lab., N. Mex.). pp 22 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43354 SYSTEMATICS OF $K\pi = 0-$ AND $1-$ OCTUPOLE BANDS IN TRANSITIONAL NUCLEI. Hamilton, J. H.; Johnson, N. R.; Riedinger, L. L.; McMillan, D. J.; Kluk, A. F.; Whitlock, L. C. (Vanderbilt Univ., Nashville, Tenn. Oak Ridge National Lab., Tenn.). pp 23 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43355 PROPERTIES OF THE 2+ AND 4+ MEMBERS OF THE BETA AND GAMMA VIBRATIONAL BANDS IN ^{156}Gd. Hamilton, J. H. (Vanderbilt Univ., Nashville, Tenn.); McMillan, D. J.; Manthuruthil, J. C.; Amtey, S. R.; Pinajian, J. J. pp 24 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43356 A NEW HIGH SPIN ISOMER ^{179m2}Hf AND INTRABAND BRANCHINGS IN THE GROUND STATE ROTATIONAL SEQUENCE OF ^{179}Hf. Huebel, H. (Princeton Univ., N. J.); Naumann, R. A.; Andersen, M. L.; Larsen, J. S.; Nielsen, O. B.; Poulsen, N. O. Roy. pp 25 of Contributions to the International Conference on Properties of Nuclear States, Montreal Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43357 REGULARITIES IN GAMMA SPECTRA RESULTING FROM THERMAL NEUTRON CAPTURE BY EVEN–EVEN Yb ISOTOPES. Namenson, A. I.; Ritter, J. C. (Naval Research Lab., Washington, D. C.). pp 26 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43358 COLLECTIVE STATES IN ^{191}Ir AND ^{193}Ir. Norgard, P. (Royal Veterinary and Agricultural Univ., Copenhagen); Bisgard, K. Maack; Gregersen, K.; Morgen, P. pp 28 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43359 MATRIX ELEMENTS BETWEEN COLLECTIVE STATES IN ^{152}Sm. Hagemann, G. B.; Herskind, B.; Olesen, M. C.; Elbek, B. (Univ. of Copenhagen). pp 29 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43360 EXCITED $K^{\pi} = 0^{+}$ BANDS IN ^{172}Yb. Greenwood, R. C.; Reich, C. W.; Harlan, R. A. (Idaho Nuclear Corp., Idaho Falls). pp 32 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43361 THE LEVEL STRUCTURES OF ^{232}Th AND ^{238}U. McMurray, W. R.; van Heerden, I. J.; Spitz, L. M.; van der Merwe, P. (Southern Universities Nuclear Inst., Faure, S. Afr.). pp 33 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43362 VIBRATIONAL BANDS IN ^{156}Dy. Ward, D.; Stephens, F. S.; Diamond, R. M.; Neiman, M. (Univ. of California, Berkeley, Calif.). pp 34 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43363 DECAY OF ^{159}Eu. Kemnitz, P.; Funke, L.; Kaun, K.-H.; Sodan, H.; Winter, G. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). pp 36 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43364 ^{223}Ra, NUCLEUS WITH INTERMEDIATE DEFORMATION. Briancon, Ch.; Walen, R. J. (Centre de Spectrometrie Nucleaire, Orsay, France). pp 37 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43365 BETA DECAY OF ^{90}Kr AND ^{91}Kr. Mason, J. F.; Johns, M. W. (McMaster Univ., Hamilton, Ont.). pp 43 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43366 DECAY OF ^{99}Mo. Cook, W. B.; Schellenberg, L.; Johns, M. W. (McMaster Univ., Hamilton, Ont.). pp 44 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43367 NUCLEAR MATRIX ELEMENTS IN THE DECAY OF ^{186}Re AND ^{188}Re AND THE CVC THEORY. Habib, E. E.; Ogata, H. (Univ. of Windsor, Ont.). pp 48 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43368 DESCRIPTION OF THE POSITIVE PARITY STATES IN ODD Xe ISOTOPES IN THE FRAMEWORK INTERMEDIATE COUPLING APPROACH OF THE UNIFIED MODEL. Paradellis, T.; Hontzeas, S. (Univ. of Saskatchewan, Sasatoon). pp 50 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43369 PARTICLE-CORE COUPLING IN ^{205}Tl. Solf, J.; Hering, W. R. (Max-Planck-Inst., Heidelberg). pp 53 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43370 CORE EXCITED STATES IN ^{207}Bi. Rieck, D.; Grosse, E.; Keller, J.; Hering, W. R. (Max-Planck-Inst., Heidelberg). pp 55 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43371 COULOMB EXCITATION OF THE COLLECTIVE SEPTUPLET AT 2.6 MeV IN ^{209}Bi^{+}. Hertel, J. W.; Fleming, D. G.; Schiffer, J. P.; Gove, H. E. (Univ. of Rochester, N. Y.). pp 56 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43372 GAMMA DECAY OF LOW-LYING STATES IN ^{208}Bi. Proetel, D. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Haberkant, K.; Pingel, K.; von Brentano, P.; Dost, M. pp 57 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43373 ENERGY LEVELS OF ^{127}I. Ward, D.; Geiger, J. S.; Graham, R. L. (Chalk River Nuclear Labs., Ont.). pp 58 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43374 GAMMA DECAY OF THE $(p_{\frac{1}{2}}^{-} \oplus 3^{-})$ DOUBLET IN ^{207}Pb. Dost, M. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Haberkant, K.; Proetel, D.; von Brentano, P.; Hertel, J.; Koerner, H. J. pp 61 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43375 NATURE OF THE 268-keV LEVEL IN ^{197}Au. Prasad, K. G.; Sharma, R. P.; Thorsar, B. V. (Tata Inst. of Fundamental Research, Bombay). pp 62 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43376 EFFECTS OF ROTATIONAL INVARIANCE ON THE SPECTRA OF ROTATING NUCLEI. Gupta, R. K.; Trainor, L. E. H. (Univ. of Toronto). pp 64 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43377 ON THE DECAY SCHEME OF ^{141}Pm. Charvet, A.; Duffait, R.; Chery, R. (Univ., Lyon). pp 66 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43378 VARIATIONS IN THE NUCLEAR CHARGE RADII OF ^{124,126,128,130}Te FROM THE DATA ON ISOTOPIC SHIFTS OF THE X-RAY $K_{\alpha 1}$ LINES. Sumbaev, O. I.; Mesentsev, A. F.; Marushenko, V. I.; Rilnikov, A. S.; Ivanov, G. A.; Egorov, A. I. (Ioffe Physico-technical Inst., Leningrad). pp 67 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43379 ANALYSIS OF MUONIC X-RAY SPECTRA OF DEFORMED NUCLEI. Chen, Min-yi (Columbia Univ., New York). pp 72 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43380 A PROPOSED LEVEL SCHEME FOR ^{146}Gd FROM THE STUDY OF THE ^{144}Sm$(\alpha,2n\gamma)^{146}$Gd REACTIONS. Spoelstra, B. (University Coll. of Zululand, Empageni, S. Afr.); Rautenbach, W. L. pp 75 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43381 A SYSTEMATIC OF EXCITED STATES OF EVEN CADMIUM NUCLEI STUDIED BY $(\alpha,xn\gamma)$ REACTIONS. Hashizume, A.; Inamura, T.; Katou, T.; Tendow, Y.; Yamazaki, T.; Nomura, T. (Inst. of Physical and Chemical Research, Yamato-Machi, Saitama, Japan. Univ. of Tokyo). pp 76 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Can-

ada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43382 ON-LINE GAMMA RAY AND CONVERSION ELECTRON STUDIES OF NUCLEAR LEVEL STRUCTURE IN THE A = 180 REGION. Konijn, J. (Univ. of Colorado, Boulder, Inst. v. Kernphysisch Onderzoek, Amsterdam); Klank, B.; Jett, J. H.; Ristinen, R. A. pp 77 of Contributions to the International Conference of Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43383 ROTATIONAL LEVELS IN ^{167}Tm. Noma, H.; Shibata, T.; Yoshizawa, Y. (Osaka Univ.). pp 78 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43384 THE INVESTIGATION OF LEVELS IN ^{167}Tm BY THE REACTION ^{165}Ho(α,2nγ)^{167}Tm. Winter, G.; Funke, L.; Hohmuth, K.; Kaun, K. H.; Kemnitz, P.; Sodan, H. (Zentral-institut fuer Kernforschung Rossendorf, Ger.). pp 79 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43385 ISOMERIC GAMMA RADIATION FROM NEUTRON-RICH FRAGMENTS IN THERMAL NEUTRON FISSION OF ^{235}U. Kaminker, D. M.; Petrov, G. A.; Popeko, L. A. (Ioffe Physico-Technical Inst., Leningrad). pp 81 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43386 DEFORMATION IN RUTHENIUM NUCLEI. Zicha, G.; Loebner, K. E. G.; Maier-Komor, P.; Maul, J.; Kienle, P. (Technische Hochschule, Munich). pp 83 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43387 STUDY OF THE DEFORMATION OF EXCITED STATES IN ^{133}La. Gerschel, C.; Husson, J. P.; Perrin, N.; Valentin, L. (Inst. de Physique Nucleaire, Orsay, France). pp 85 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43388 PERSPECTIVES IN THE SYNTHESIS AND SEARCH FOR SUPER-HEAVY TRANSURANIUM ELEMENTS. Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 86 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43389 PRIMARY COLLECTIVE LEVELS IN EVEN–EVEN PLATINUM. Foucher, R.; Henck, R.; Husson, J. P.; (and others). (CERN, Geneva). pp 87 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43390 g-FACTOR OF THE $\frac{1}{2}^+$ STATE OF ^{123}Te. Rots, M.; Van Esch, R.; Coussement, R. (Louvain Univ., Belgium). pp 89 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43391 g-FACTOR OF THE SECOND EXCITED 2^+ STATE IN ^{192}Pt. Grabowski, Z. W. (Purdue Univ., Lafayette, Ind.). pp 95 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43392 MAGNETIC CORE POLARIZATION IN THE $(h_{\frac{9}{2}})8^+$ STATE OF ^{210}Po. Yamazaki, T. (Inst. of Physical and Chemical Research, Yamato-Machi, Saitamaken, Japan. Tokyo Univ.); Nomura, T.; Kata, U.; Inamura, T.; Hashizume, A.; Tendow, Y. pp 96 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43393 SPIN DEPENDENCE OF THE DEORIENTATION OF RECOILING FREE ATOMS. Nordhagen, R.; Goldring, G.; Diamond, R. M.; Nakai, K.; Stephens, F. S. (Univ. of California, Berkeley). pp 97 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43394 MEASUREMENT OF COULOMB EXCITATION PROBABILITIES IN ^{166}Er: REORIENTATION OF THE 2^+ AND 4^+ LEVELS. Ward, D. (Chalk River Nuclear Labs., Ont.); Ewan, G. T.; Simpson, J. J. pp 98 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43395 QUADRUPOLE MOMENTS OF THE FIRST 2^+ STATES OF ^{104,106}Pd AND ^{130}Te. Christy, A.; Hall, I.; Harper, R. P.; Naqib, I. M.; Wakefield, B. (Univ. of Liverpool). pp 99 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43396 ON THE DECAY OF ^{131}Cs. Fechner, J. (Univ., Bonn); Hammesfahr, A.; Kluge, A.; Toschinski, H.; Voss, J.; Weigt, P.; Martin, B.; Sen, S. K. pp 103 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43397 RESONANT SCATTERING OF BREMSSTRAHLUNG BY ^{144}Nd LEVELS. Metzger, F. R. (Franklin Inst., Swarthmore, Pa.). pp 105 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43398 COULOMB EXCITATION OF ^{139}La VIA INELASTIC SCATTERING OF ALPHA PARTICLES. Bouley, Alan C.; Graetzer, R. (Pennsylvania State Univ., University Park). pp 106 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43399 LIFETIME OF THE FIRST EXCITED STATE OF ^{91}Sr. Mason, J. F.; Boulter, J. F.; Prestwich, W. V.; Johns, M. W. (McMaster Univ., Hamilton, Ont.). pp 119 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43400 ELECTROMAGNETIC PROPERTIES OF LEVELS OF ^{192}Pt AND ^{194}Pt. Bruton, E. J.; Gibb, A. W.; Kenyon, D. B.; Keszthelyi, L.; Cameron, J. A. (McMaster Univ., Hamilton, Ont.). pp 123 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43401 INELASTIC ELECTRON SCATTERING FROM ^{90}Zr. Bockelman, C. K. (Yale Univ., New Haven); Curtiss, T. H.; Eisenstein, R. A.; Madsen, D. W.; Bellicard, J. B.; Leconte, P. pp 132 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43402 E3 ISOMER IN ^{105}Ag. Hopke, P. K.; Naumann, R. A.; Spejewski, E. H.; Strigachev, A. T. (Princeton Univ., N. J.). pp 135 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43403 THE DECAY OF ^{103}Ru. Sud, S. P.; Suri, K. K.; Arora, B. K.; Mangal, P. C.; Trehan, P. N. (Panjab Univ., Chandigarh, India). pp 136 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada,

August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43404 STUDY OF SOME TELLURIUM ISOTOPES BY SPECTROSCOPY AND COULOMB EXCITATION. Albouy, G.; Lagrange, J. M.; Pautrat, M.; Poffe, N.; Sergolle, H.; Vanhorenbeeck, J. (Institut de Physique Nucleaire, Orsay, France). pp 143 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43405 ONE OCTUPOLE–ONE QUADRUPOLE PHONON STATES OF ^{110}Pd. Robinson, R. L.; Deye, J. A.; Ford, J. L. C. Jr.; Stelson, P. H.; Tamura, T.; Wong, C. Y. (Oak Ridge National Lab., Tenn.). pp 151 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43406 ANALYSIS OF (p,p') SCATTERING AT 155 MeV USING MICROSCOPIC DESCRIPTIONS OF THE ISOTOPES ^{116}Sn, ^{118}Sn, AND ^{120}Sn. Comparat, V.; Desnoyers, A.; Marty, N.; Willis, A. (Institut de Physique Nucleaire, Orsay, France). pp 156 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43407 CORE RENORMALIZATION EFFECTS IN THE LEAD REGION. Freed, N.; Gibbons, J. (Pennsylvania State Univ., University Park). pp 173 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43408 PARTICLE–HOLE INTERACTIONS IN ^{90}Zr. Freed, N.; Rhodes, W. (Pennsylvania State Univ., University Park). pp 174 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43409 RECENT WORK ON SUPER-HEAVY NUCLEI. Flerov, G. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 175–88 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

The experiments are described, which look for the Z = 114 element in nature. The effect of spontaneous fission was observed for some samples. It cannot be explained by spontaneous fission of the uranium impurity nor by induced fission of lead and thorium. The conclusion was made on the existence of a new spontaneously fissioning activity. It is suggested as a probable explanation that this activity is related to the decay of a superheavy isotope with half-life of order of 10^8 years or more and the concentration less than 10^{-10}%. (auth) (Canada)

43410 INELASTIC PROTON SCATTERING FROM ^{207}Pb AND CORE POLARIZATION. McManus, H.; Borysowicz, J.; Hammerstein, R.; Benenson, W.; Petrovich, F. (Michigan State Univ., East Lansing). pp 189 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43411 NUCLEI FAR OFF THE STABILITY LINE. Hansen, P. G. (Univ. of Aarhus, Denmark. CERN, Geneva). pp 189–201 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

Some experimental results obtained with the ISOLDE on-line isotope separator at CERN are reviewed. The systematics of α-widths and of beta-decay strength functions are discussed. (auth) (Canada)

43412 THREE-QUASIPARTICLE MULTIPLETS IN NUCLEI BELOW N = 82. Beery, D. B.; Muthukrishnan, R.; Kelley, W. H.; McHarris, Wm. C. (Michigan State Univ., East Lansing). pp 203 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43413 STATIC MOMENTS OF NUCLEI. Goldring, G. (Weizmann Inst. of Science, Rehovoth, Israel). pp 205–20 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

The magnetic dipole and electric quadrupole moments of low-energy excited 2^+ states were measured in the transition and rotational region (A = 120 – 170). The results of these measurements are discussed along with the experimental techniques pertaining to hyperfine fields. (auth) (Canada)

43414 NEGATIVE PARITY STATES IN ^{91}Nb. Hughes, T. A. (IBM Scientific Center, Houston, Tex.). pp 220 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43415 MATRIX ELEMENTS FOR THE $1^- \rightarrow 0^+$ BETA-DECAY OF ^{148}Pm. Amadori, R. A.; Horgan, J. R., Jr.; Sastry, K. S. R. (Univ. of Massachusetts, Amherst). pp 225 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43416 THE DECAY SCHEME OF THE SEPTUPLET IN THE NUCLEUS ^{209}Bi. Hamamoto, I. (Univ. of Copenhagen). pp 228 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43417 A CALCULATION OF ^{206}Pb, ^{206}Hg, AND ^{206}Tl WITH THE HAMADA–JOHNSTON POTENTIAL. Herling, G. H.; Kuo, T. T. S. (State Univ. of New York, Stony Brook). pp 229 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43418 A CALCULATION OF ^{210}Pb, ^{210}Po, AND ^{210}Bi WITH THE HAMADA–JOHNSTON POTENTIAL. Herling, G. H.; Kuo, T. T. S. (State Univ. of New York, Stony Brook). pp 230 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43419 SHELL MODEL STUDY OF SEPTUPLET IN ^{209}Bi. Arita, K.; Horie, H. (Tokyo Inst. of Tech.). pp 231 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43420 HARTREE–FOCK CALCULATIONS WITH SKYRME'S INTERACTION. Brink, D. M.; Vautherin, D. (Institut de Physique Nucleaire, Orsay, France). pp 232 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43421 ^{207}Pb(p,p'γ)^{207}Pb IN THE REGION OF PARTICLE-HOLE ISOBARIC ANALOGUE RESONANCES. Bartholomew, G. A. (Chalk River Nuclear Labs., Ont.); Earle, E. D.; Ferguson, A. J.; Lone, M. A.; Bergqvist, I. pp 233 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43422 PRELIMINARY RESULTS OF SELF-CONSISTENT CORE-PARTICLE COUPLING CALCULATIONS FOR THE TIN ISOTOPES. Dreiss, Gerald (Northeastern Univ., Boston); Do Dang, G.; Dreizler, R. M.; Klein, A. pp 241 of Contributions to the International Conference on Properties of Nuclear States,

Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43423 HARTREE–FOCK DENSITY OF ^{208}Pb AND ELECTRON ELASTIC SCATTERING. Vautherin, D.; Veneroni, M. (Institut de Physique Nucleaire, Orsay, France). pp 245 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43424 BHMM ANALYSIS OF THE ^{208}Pb(d,p)^{209}Pb$_{g.s.}$ REACTION. King, K.; McKellar, B. H. J. (Univ. of Sydney). pp 249 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43425 ENERGY LEVELS OF ^{113}Sn AND ^{123}Sn. Borello, T.; Dietzsch, O.; Frota-Pessoa, E.; Hamburger, E. W.; Orsini, C. Q. (Univ., Sao Paulo, Brazil). pp 250 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43426 SINGLE-PROTON TRANSFER REACTIONS ON ACTINIDE TARGETS. Elze, Th. W.; Huizenga, J. R. (Univ. of Rochester, N. Y.). pp 253 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43427 SPECTROSCOPIC FACTORS FOR NEUTRON PARTICLE-HOLE STATES IN ^{142}Nd. Dietzsch, O. (Univ., Sao Paulo, Brazil); Foster, J. L. pp 263 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43428 REACTIONS ^{106,114}Cd(^{3}He,d)^{107,115}In. Conjeaud, M.; Harar, S.; Thuriere, E. (CEN, Saclay, France). pp 264 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43429 REACTION ^{130}Te(t,α)^{129}Sb. Conjeaud, M. (CEN, Saclay, France); Fernandez, B.; Harar, S.; Thuriere, E.; Chatterjee, M. L.; Kostalac, B.; Turk, M. pp 265 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43430 PROTON PARTICLE-HOLE STATES IN 120 AND 122 TIN ISOTOPES. Conjeaud, M. (CEN, Saclay, France); Fernandez, B.; Harar, S.; Thuriere, E.; Chatterjee, M. L.; Cindro, N.; Turk, M. pp 268 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43431 SPECTROSCOPY OF N = 82 NUCLEI USING THE REACTIONS (p,d) AND (p,t) AT 24.55 MeV. Bruge, G.; Chaumeaux, A.; Ha Duc, Long; Picard, J. (CEN, Saclay, France). pp 270 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF- 690804.

43432 POLARIZATION EFFECTS IN THE ^{207}Pb(d,p)^{208}Pb REACTION NEAR THE COULOMB BARRIER. Debenham, A. A.; Griffith, J. A. R.; Irshad, M.; Roman, S. (Univ. of Birmingham, Eng.). pp 273 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43433 THE STRUCTURE OF ^{142}Sm, ^{143}Sm, ^{145}Sm, AND ^{146}Sm. Edwards, V. R. W. (King's Coll., London); Ganguly, N. K.; Montague, D. G.; Ramavataram, K.; Zucker, A.; Plummer, D. J. pp 277 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43434 STUDY OF DEFORMATION EFFECTS BY FAST NEUTRON ELASTIC SCATTERING. Holmqvist, B. (AB Atomenergi, Studsvik, Sweden); Wiedling, T.; Benzi, V.; Zuffi, L. pp 279 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43435 NEUTRON SINGLE-HOLE STATES IN ^{149}Sm, ^{157}Gd, AND ^{196}Au INVESTIGATED BY (p,d) REACTIONS. Yagi, K. (Osaka Univ.); Saji, Y.; Ishizaki, Y.; Ishimatsu, T. pp 281 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43436 THE ^{206}Pb(p,t)^{204}Pb REACTION AT 22 MeV. Holland, G. E.; Whitten, C. A. Jr.; Stein, Nelson; Bromley, D. A. (Yale Univ., New Haven). Contract AT(30)-3223. pp 288 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43437 THE (p,t) REACTION ON ^{119}Sn AND ^{117}Sn. Holland, G. E.; Whitten, C. A. Jr.; Maher, J.; Bromley, D. A. (Yale Univ., New Haven). pp 289 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43438 THE ^{148}Nd(t,p)^{150}Nd REACTION. Chapman, R. (Atomic Energy Research Establishment, Harwell, Eng.); Kitching, J.; McLatchie, W. pp 291 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43439 ALPHA-PARTICLE REACTION CROSS SECTIONS IN ^{208}Pb BELOW THE COULOMB BARRIER. Barnett, A. R.; Lilley, J. S. (Univ. of Minnesota, Minneapolis). pp 296 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43440 EVIDENCE FOR ALPHA CLUSTERING IN HEAVY NUCLEI FROM (p,α) REACTIONS. Kulisic, P.; Tandon, G. K.; Falk, W. R.; Kidney, R. (Univ., Manitoba, Winnipeg). pp 298 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43441 STRONG L = 0 AND 2 TRANSITIONS IN (p,t) REACTIONS ON EVEN-MASS Nd ISOTOPES. Yagi, K.; Acki, Y.; Kawa, J.; Sato, K. (Osaka Univ.). pp 300 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43442 A MICROSCOPIC DESCRIPTION OF THE ANALOGUE OF THE ^{208}Pb GROUND STATE. Ramavataram, S. (Univ., Laval, Quebec); Wilmore, D.; Edens, D. J. pp 312 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43443 ANGULAR DISTRIBUTION OF INELASTIC PROTONS FROM ISOBARIC ANALOG RESONANCES IN ^{131}I. Burde, J.; Engler, G.; Ginsburg, A.; Jaffe, A. A.; Marinov, A.; Birstein, L. (Hebrew Univ., Jerusalem). pp 313 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43444 MEASUREMENT AND ANALYSIS OF THE ^{91}Zr GROUND STATE ANALOG. Scott, Hugh L.; Swann, C. P.; Rauch, F. (Franklin Inst., Swarthmore, Pa.). pp 315 of Contributions to the International Conference on Properties

of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43445 COLLECTIVE STATES AND γ-RAY DECAY OF ISOBARIC ANALOGUE STATES IN ^{56}Fe. Kiessling, M.; Friedrich, R.; Otto, G. (Karl-Marx-Univ., Leipzig). pp 316 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43446 SINGLE-NEUTRON STRUCTURE IN THE LEAD REGION FROM ISOBARIC ANALOG RESONANCES. Stein, Nelson; Coffin, J. P.; Whitten, C. A. Jr.; Bromley, D. A. (Yale Univ., New Haven). pp 319 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43447 ISOBARIC ANALOG RESONANCES IN THE ^{209}Bi(p,p') REACTION. Coffin, J. P.; Stein, Nelson; Cleary, T.; King, C.; Bromley, D. A. (Yale Univ., New Haven). pp 320 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43448 ANALOGUE STATES OF ^{140}La LEVELS. Temmer, G. M. (State Univ., New Brunswick, N. J.); Cassagnou, Y.; Foissel, P.; Lamehi-Rachti, M.; Levi, C.; Mittig, W.; Papineau, L. pp 323 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43449 MICROSCOPIC CALCULATION OF ELASTIC PROTON WIDTH OF AN ISOBARIC ANALOGUE RESONANCE. Alders, R. D.; Zaidi, S. A. A. (Univ. of Texas, Austin). pp 329 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43450 STATES OF THE $(g_{9/2})^2$ CONFIGURATION IN ^{90}Nb. Bearse, R. C.; Stoltzfus, J. C.; Stautberg, M. M.; Schiffer, J. P.; Comfort, J. R. (Argonne National Lab., Ill.). pp 330 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43451 ANALYSES OF ANALOG RESONANCE DATA IN TERMS OF A K-MATRIX APPROACH. Bledsoe, H.; Coker, W. R.; Tamura, T. (Univ. of Texas, Austin). pp 331 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43452 THE ^{208}Pb(p,n)^{208}Bi REACTION IN THE 30-50 MeV RANGE. Igo, G. J. (Univ. of California, Los Angeles); Perrenoud, Jean-Luc; Rogers, J. G.; Verba, J. W.; Whitten, C. A. Jr.; Woods, T. J.; Young, J. C.; Welch, L. pp 332 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43453 DAMPING WIDTH OF THE DIPOLE GIANT RESONANCE IN ^{208}Pb. Davidson, A. M.; MacDonald, N. (Univ. of Glasgow). pp 347 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONFf90804.

43454 VIBRATIONAL AND ISOSPIN SPLITTING OF THE ^{106}Pd GIANT DIPOLE RESONANCE. Deague, T. K.; Muirhead, E. G.; Spicer, B. M. (Univ. of Melbourne). pp 350 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43455 ROLE OF THE CONTINUUM IN RPA CALCULATIONS. Dover, C. B.; Kietrich, K.; Hahne, F. J. W. (Univ., Heidelberg). pp 358 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43456 ROBSON ENHANCEMENT STUDIED BY (p,p'γ) ANGULAR CORRELATIONS ON CADMIUM ISOTOPES. Abramson, E.; Plesser, I.; Vager, Z.; Wurm, J. P. (Weizmann Inst. of Science, Rehovoth, Israel). pp 369 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43457 CALCULATION OF REDUCED α-WIDTHS OF LEVELS OF ^{210}Bi WITH TENSOR FORCES IN THE PAIRING INTERACTION. Baktybaev, K. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat., No. 6, 1-4(Nov.-Dec. 1968). (In Russian).
The alpha decay widths for ^{210}Bi are calculated accounting for central and tensor forces in the pairing interaction. The relative decay probabilities are compared with the experimental values. The level scheme of ^{206}Tl resulting from ^{210}Bi α-decay is discussed. (J.W.R.)

43458 DECAY OF ^{103}Ru. Sud, S. P.; Suri, K. K.; Trehan, P. N. (Panjab Univ., Chandigarh, India). J. Phys. Soc. Jap.; 28: 1387-95(Jun 1970).
The gamma rays in the decay of ^{103}Ru to ^{103}Rh were investigated with scintillation spectrometers in fast-slow coincidence, sum-coincidence and sum-peak coincidence modes. In the literature there is a lot of ambiguity about the existence of 65-, 112-, 176-, 322- and 362-keV gamma transitions. Present measurements confirm the existence of these transitions. A 362-keV gamma transition between the 362-keV level and the ground state of ^{103}Rh was found to have an intensity $\leq$0.01%. Directional correlations of the 445-53 and 557-53 keV cascades were observed and indicate spin-parity assignments $^9/_2{}^+$, $^7/_2{}^-$ and $^5/_2{}^-$ for the 93-, 538- and 650-keV levels of ^{103}Rh. (auth)

43459 DECAYS OF ^{143}Pm, ^{144}Pm, AND ^{146}Pm. Avotina, M. P.; Grigor'ev, E. P.; Zolotavin, A. V.; Sergeev, V. O.; Sovtsov, M. I.; Veis, M.; Urbanets, Ya.; Vrzal, Ya.; Liptak, Ya. (Leningrad State Univ.). Yadern. Fiz.; 11: 1133-40(Jun 1970). (In Russian).
Inner conversion electron and γ-ray spectra from ^{143}Pm (250 days), ^{144}Pm (360 days), and ^{146}Pm (2020 days) are investigated with a magnetic-type $\pi\sqrt{2}$ spectrometer and a semiconductor spectrometer with Ge(Li) detector. Energies, intensities, and multipolarities of the γ transitions are determined. Energies and quantum numbers are obtained for the daughter Nd isotopes: ^{143}Nd, 741.9 keV ($^7/_2{}^-$); ^{144}Nd, 696.5(2^+), 1314.4(4^+), 1510.8(3^-), 1791.2(6^+), 2093.1(5^-), and 2204.4 keV; ^{146}Nd, 453.8(2^+), 1043(4^+), and 1189.5(3^-) keV. (auth)

43460 MASS-SPECTROMETRIC DETERMINATION OF Xe ISOTOPE RELATIVE YIELDS FROM THE NATURAL URANIUM FISSION BY 14.7 MeV NEUTRONS. Petrzhak, K. A.; Teplykh, V. F.; Pan'yan, M. G. (Leningrad Technological Inst.). Yadern. Fiz.; 11: 1178-81(Jun 1970). (In Russian).
Xe isotope relative yields in the fission of ^{238}U by 14.7-MeV neutrons were measured using a high-sensitive mass spectrometer. It is found that the fine structure of the yield curve is in the region of mass 134 as in case of the fission of ^{238}U by fission spectrum neutrons. Contrary to the wide-spread concept on the smooth yield curve with the increase of the excitation energy of the fissible nucleus, it is shown that the increase of the ^{239}U excitation energy from 7.7 up to 18.9 MeV results in the more strictly pronounced peak of the fine structure. (auth)

Nuclear Theory

Refer also to abstracts 42884, 42889, 42894, 42928, 42930, 42934, 42985, 42987, 42995, 43296, and 43422.

43461 (AAEC/TM-536) THE CALCULATION OF NEUTRON CROSS SECTIONS AT ENERGIES BETWEEN 0.5 MeV AND 15 MeV. Bertram, W. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr 1970. 16p. Dep. CFSTI (U. S. Sales Only).
The optical model is used to calculate the elastic, nonelastic, and total cross sections for scattering of neutrons, with energies between 0.5 and 15 MeV, by nuclei in the mass range $65 \leq A \leq 160$. A simple method for determining the compound elastic scattering cross section is given. (auth) (Australia)

43462 (IAE–1855) METHOD FOR CALCULATING THE ENERGY SPECTRUM OF LOW-LYING STATES OF SPHERICAL NUCLEI. Sapershtein, E. E.; Khodel, V. A. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1969. 72p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The calculation of the energy spectrum of low-lying states of spherical nuclei is considered. An equation was obtained which permits the expression of the amplitude of the paired interaction as an effective interaction potential. (L.T.W)

43463 (RLO–1388-573) MESON DYNAMICS AND THE NUCLEAR MANY-BODY PROBLEM. Brown, W. D.; Puff, R. D.; Wilets, L. (Washington Univ., Seattle). [1968]. 68p. Dep. CFSTI.

Relativistic nucleon-meson field theory is cast in a form appropriate to the nuclear many-body problem. Martin Schwinger thermodynamic Green's functions are employed. The n-nucleon Green's functions satisfy a set of coupled equations which is formally identical to the usual potential many-body problem. Here, however, the two-body potential is replaced by a time dependent interaction in which the mesons are formally eliminated in favor of higher order nucleon correlations. A general program of increasing complexity for obtaining approximate solutions to the equations is discussed. It is necessary to solve the "vacuum" (one, two, etc., nucleon propagator) first. This has been done in the "Hartree–Fock" approximation which sums all diagrams containing a single continuous nucleon line with all possible uncrossed pi and omega meson lines. Peaks in the spectral function are identified with masses of known N* resonances. The appearance of ghost states which arise in the process of mass and wave function renormalization is discussed. The resultant Green's function is used to calculate the magnetic moment of the nucleon, yielding a significantly better isovector component of the magnetic moment than the usual perturbation theory, although the isoscalar component is poor in both cases. (auth)

43464 (UJV–2433-F) ABSORPTION MODEL FOR DIRECT TRANSFER REACTIONS. Dobes, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1970. 24p. Dep. CFSTI (U. S. Sales Only).

A simple model for direct transfer reactions is investigated. The transition amplitude is evaluated by means of the geometric mean (Sopkowich) formula with the sharp cut-off model for elastic scattering. An easy numerical computation removing a number of approximations adopted in previous papers is performed. The model is tested for some (d,p) and (p,d) reactions. Satisfactory agreement with experimental angular distributions and reasonable spectroscopic factors have been obtained. (auth)

43465 ALTERNATIVE EVALUATION OF TERNARY-FISSION DATA. Steinberg, E. P.; Wilkins, B. D.; Kaufman, S. B.; Fluss, M. J. (Argonne National Lab., Ill.). Phys. Rev., C; 1: 2046-50 (Jun 1970).

An analysis of semiconductor detector measurements of ternary-fission events indicates that scattering is probably not effectively eliminated. An alternative interpretation of the observed results is given, which is consistent with the presence of scattered fission fragments. A mass or nuclear-charge identification for the third fragment in such experiments is suggested to establish unequivocal results. (auth)

43466 PERTURBATION EFFECTS AND MORSE FUNCTION BASED ON THE VELOCITY-DEPENDENT POTENTIAL. Lodhi, M. A. K. (Texas Tech. Univ., Lubbock). Phys. Rev., C; 1: 1895-1900(Jun 1970).

A velocity-dependent nucleon-nuclear potential approximated to the well-known Morse function is employed to generate the single-particle wave functions and eigenvalues for all nuclei. A general method of treating the perturbation is prescribed which gives a very good agreement with the data on separation energies and with other theoretical work. (auth)

43467 CORE EXCITATION IN A STRIPPING REACTION. McCarthy, I. E. (Flinders Univ. of South Australia, Bedford Park); Pal, Dipti. Phys. Rev., C; 1: 2000-11(Jun 1970).

^{44}Ca(d,p)^{45}Ca stripping, corresponding to the various excited states of ^{45}Ca, is calculated by including the effect of excitation of the 2^+ state of the ^{44}Ca core in the stripping process. In this calculation, the term appearing in the stripping amplitude from the proton-core residual interaction is retained, and its effect is found to be quite important. It is concluded that in the cases where the stripping cross section is very small, the usual distorted-wave Born-approximation analysis, which ignores the above effect, may lead one to incorrect conclusions. On the whole, our calculated cross sections show some of the so-called nonstripping features which have been recently observed in a large number of stripping experiments. (auth)

43468 LEVEL STRUCTURE OF ^{43}Sc AND ODD-MASS Ca ISOTOPES WITH REACTION MATRIX ELEMENTS. Kung, H. W.; Singh, R. P.; Raj, R.; Rustgi, M. L. (State Univ. of New York, Buffalo). Phys. Rev., C; 1: 1994-9(Jun 1970).

Employing ^{40}Ca as the core, the odd-parity states of ^{43}Sc and ^{43}Ca are calculated within the shell-model framework using the reaction matrix elements of the Hamada–Johnston nucleon-nucleon potential as calculated by Kuo and Brown. The three extra-core particles are considered to occupy the 0f–1p orbitals. The effect of including the additional $0g_{9/2}$ orbital is also investigated. The odd-mass calcium isotopes (^{43}Ca, ^{45}Ca, and ^{47}Ca) are then described by the modified Tamm–Dancoff approximation (MTDA) method and the results are compared with the shell-model calculations of Federman and Talmi and of Engeland and Osnes that have been carried out in a much more restricted configuration space. The MTDA calculations are also performed with the reaction matrix elements of the Tabakin interaction for comparison with the Hamada–Johnston results. (auth)

43469 OFF-SHELL T MATRIX AND THE JOST FUNCTION. Fuda, Michael G. (State Univ. of New York, Buffalo). Phys. Rev., C; 1: 1910-24(Jun 1970).

An off-shell effective-rangelike theory is developed for the low-energy two-nucleon T matrix. It is shown that the parameters in the theory can be determined from on-shell scattering data. The parameters are determined from the $^3S_1$ and $^1S_0$ two-nucleon phase shifts, and the validity of the off-shell formula is tested by means of examples. For the cases considered, the formula is found to work very well. A new proof for the separability of the two-body T matrix near bound-state and resonance energies is given. This proof is based on the properties of the T matrix in configuration space. A theorem on the factorization of the Jost function is developed and used to solve the inversion problem for rank-two separable potentials. Results are given for phase shifts that become hard-core phase shifts at high energies and for tensor forces. These results allow one to construct a separable potential that has the same on-shell T matrix and bound-state wave function as a realistic local potential. (auth)

43470 UNIQUE SECOND- AND THIRD-FORBIDDEN β DECAY. Warburton, E. K.; Garvey, G. T.; Towner, I. S. (Nuclear Physics Lab., Oxford). Ann. Phys. (N. Y.); 57: 174-200(Mar 1970).

The unique second-forbidden β-decay matrix elements of ^{10}Be → ^{10}B, ^{22}Na → ^{22}Ne and ^{26}Al → ^{26}Mg are calculated using both the shell model and the unified model. The unique third-forbidden β-decay matrix elements of ^{40}K → ^{40}Ca and ^{40}K → ^{40}Ar are calculated using the shell model. All final states are ground states except for ^{26}Mg, in which case the decay is to the 2^+ first- and second-excited states. The four second-forbidden transitions are rather well described by the Nilsson form of the unified model. There is some evidence in the decay of ^{10}Be and ^{22}Na for collective suppression of the β matrix elements analogous to the collective enhancement of E2 matrix elements. The ^{10}Be → ^{10}B matrix element is also reproduced by the Cohen–Kurath shell-model wave functions. Shell-model calculations that only assume $2s_{1/2}$ and $1d_{5/2}$ configurations are less successful for ^{22}Na → ^{22}Ne and ^{26}Al → ^{26}Mg. For the spherical shell-model calculation of the ^{40}K decays, agreement cannot be reached if only the $1d_{5/2}$ and $1f_{7/2}$ shells are considered. Considerably better agreement for ^{40}K → ^{40}Ca is achieved if the j space is increased to include other 1p–1h terms in the ^{40}K wave function. It is argued that agreement cannot be reached for the ^{40}K → ^{40}Ar rate without including terms from other shells (within $1\hbar\omega$ of $1d_{5/2}$ and $1f_{7/2}$) in the dominant two-particle—two-hole wave function of ^{40}Ar, and that this phenomenon, for both ^{40}K → ^{40}Ca and ^{40}K → ^{40}Ar, follows from a general feature of n-forbidden unique β decay (with n odd) analogous to the inhibition of ground-state E1 transitions from low-lying $T = |T_z| + 1$ states and the associated appearance of an E1 giant resonance. (auth)

43471 MIRROR SYMMETRY IN THE β DECAY OF THE A = 20 AND 25 SYSTEMS. Wilkinson, D. H. (Brookhaven National Lab., Upton, N. Y. Oxford Univ.); Alburger, D. E. Phys. Rev. Lett.; 24: 1134-6(18 May 1970).

The half-life of ^{20}F is determined as 11.03 ± 0.06 sec and β branches are measured in the decay of ^{25}Na. By combining with information on ^{20}Na and ^{25}Si it is deduced that for the A = 20 mirror decays to the ^{20}Ne 2^+ first-excited state, $(ft)^+/(ft)^- = 0.933 \pm 0.032$ or 1.062 ± 0.037, while in the A = 25 system $(ft)^+/(ft)^- = 1.187 \pm 0.076$ for β decay to all states below 3 MeV. (auth)

43472 COMPACT-CLUSTER EXPANSION. II. FINITE NUCLEI. Brandow, B. H. (Cornell Univ., Ithaca, N. Y.). Ann. Phys. (N. Y.); 57: 214-95(Mar 1970).

The compact-cluster formalism, described previously for an infinite system (nuclear matter or liquid ^{3}He), is now extended to the case of closed-shell nuclei. The main concern here is with the new features arising from the fact that the one-body operators of

the theory (self-energy insertions and propagator weighting factors) are no longer diagonal in the one-body indices. Two different aspects are explored: (i) the orthogonality of the intermediate-state orbitals to the occupied-state orbitals, and (ii) the mutual orthogonality among the occupied-state orbitals. The concept of self-consistency is also carefully examined. Formally exact treatments of both aspects are presented, as well as some approximations suitable for practical calculations. For (i), it is demonstrated by explicit calculation that an "orthogonalized plane-wave" approximation should be quite satisfactory for most purposes. This provides a detailed justification for the "$Qe_R^{-1}Q$" prescription for the treatment of the exclusion principle, as first proposed by C. W. Wong. Regarding (ii), it is shown that consistent "renormalized" formulations are possible with either a nonorthogonal set of orbitals, or with a strictly orthogonal set. The nonorthogonal formulation is conceptually simpler, and is the one best suited for Brueckner–Hartree–Fock calculations carried out in r space. The orthogonal formulation is more advantageous for calculations in which the occupied orbitals are expanded in terms of a harmonic-oscillator basis. The latter formulation is quite similar to a previous result of Balian and DeDominicis. A formal error in our previous discussion, pointed out by the latter authors, is also examined. It is shown that the set of all skeleton diagrams must be supplemented by certain "compensation skeletons" in order to ensure that the final energy expression includes every Goldstone diagram once and only once. It is argued that this complication does not invalidate any of the important and useful features of the compact-cluster approach. (auth)

43473 OPTICAL POTENTIAL FROM DYNAMIC ANALYSIS OF ELASTIC ELECTRON–NUCLEUS SCATTERING. Toepffer, C. (Univ., Frankfurt am Main); Drechsel, Dieter. Phys. Rev. Lett.; 24: 1131-4(18 May 1970).

Dispersion effects in the analysis of high-energy electron-nucleus scattering lower the cross section obtained from a partial-wave analysis in its minima. At an electron energy E = 750 MeV and momentum transfer q = 3.9 fm^{-1} the correction amounts to about 70% for ^{40}Ca. These dispersion effects may be described by an optical potential whose real part is determined by the usual static charge distribution, while the small imaginary part peaks at the nuclear surface with a maximum value of about 20 keV. (auth)

43474 AUTOCORRELATION TECHNIQUE FOR DETERMINING THE AVERAGE LEVEL SPACING OF THE INTERMEDIATE SUBTHRESHOLD STRUCTURE IN THE FISSION CROSS SECTION OF ^{235}U AND ^{239}Pu. De Saussure, G. (Oak Ridge National Lab., Tenn.); Perez, R. B.; Moore, M. N. Phys. Lett.; 31B: 413-14 (30 Mar 1970).

The interpretation given to the correlogram of the ^{235}U and ^{239}Pu fission cross sections is questioned as to its validity to estimate the average level displacement in the Strutinsky well, appearing in the fission barrier for highly deformed nuclei. (auth)

43475 EVEN PARITY STATES OF ^{38}Ar. Skouras, L. D. (Univ. of Manchester, Eng.). Phys. Lett.; 31B: 439-41(30 Mar 1970).

An extended model allowing for the mixing between 2 hole and 2 particle–4 hole configurations is introduced for the interpretation of the even parity spectrum of ^{38}Ar. The theoretical results are in good agreement with experiment on both energy levels and transition rates. (auth)

43476 SECOND CLASS CURRENTS IN NUCLEAR BETA-DECAY? Wilkinson, D. H. (Nuclear Physics Lab., Oxford). Phys. Lett.; 31B: 447-50(30 Mar 1970).

All available data (11 cases) on mirror beta-decay are analyzed. The results scatter widely but the mean trend of $(ft)^+/(ft)^- - 1$ is significantly positive, consistent with a linear dependence on $W_0^+ + W_0^-$ and, without correction, would correspond to $g_{1T} \approx 2 \times 10^{-3}$ (with $g_V = 1$) for the strength of the induced tensor coupling. (auth)

43477 EFFECTS OF ANGULAR MOMENTUM ON KINETIC ENERGY RELEASE IN FISSION. Sikkeland, T. (Univ. of California, Berkeley). Phys. Lett.; 31B: 451-4(30 Mar 1970).

Values for the most probable kinetic energy release in fission following compound-nucleus reactions between various targets and ions are reproduced, with a standard deviation of 1.5 MeV, by the expression $E_K^0(MeV) = 0.0042\ Z_0^2/A_0^{\frac{1}{3}} + 0.075\ E_0$, where Z_0, A_0 and E_0 are respectively the atomic number, mass number and the excitation energy of the compound nucleus. (auth)

43478 SHELL MODEL APPROACH TO THE CALCULATION OF EFFECTIVE CHARGES. Goode, P. (Univ. of Rochester, N. Y.); Siegel, S. Phys. Lett.; 31B: 418-22(30 Mar 1970).

A microscopic core-particle coupling model is used to calculate E2 effective charges in mass-15 and mass-17, N = Z ± 1 nuclei. These charge values are compared with the corresponding ones derived from a perturbation theory approach. The close agreement in the effective charges calculated in these two approaches is due to cancellation of effects in the core-particle coupling model which are neglected in perturbation theory. (auth)

43479 GENERALIZED CONCEPTION OF FRACTIONAL PARENTAGE AND THE (α–d)–(^{3}He–t) DUALITY IN THE ^{6}Li NUCLEUS. Kurdyumov, I. V.; Neudatchin, V. G.; Smirnov, Yu. F. (Moscow State Univ.). Phys. Lett.; 31B: 426-8(30 Mar 1970).

The fractional parentage concept is generalized for the case of the nucleon cluster model. In terms of this, model calculations are made for the ^{6}Li nucleus of the wave functions $\tilde{\phi}$ of mutual cluster motion α–d and ^{3}He–t, Fourier-images of which are measured in the quasielastic knock-out reactions. Also obtained are the reduced widths θ^2 in the channels α–d and ^{3}He–t. The ^{3}He–t channel is only slightly depressed, $\theta_t^2 \approx 0.5$. The wave function $\tilde{\phi}$ (^{3}He–t) is appreciably more localized than the function $\tilde{\phi}$ (α–d), which is reflected in the form factors. (auth)

43480 ON THE EFFECTS OF "PHASE TRANSITIONS" AT THE GIANT DIPOLE RESONANCE EXCITATIONS. Semenko, S. F. (Lebedev Inst. of Physics, Moscow); Vasil'ev, O. V.; Semenov, V. A. Phys. Lett.; 31B: 429-32(30 Mar 1970).

Possible effects, resulting from change of the nucleus average field deformation at the dipole excitations, are considered. The data of the photoneutron experiments, performed for N ≈ 90 nuclei, are in agreement with this treatment. (auth)

43481 ON A SOLUTION OF THE NUCLEAR THREE BODY PROBLEM IN COORDINATE SPACE. Borysowicz, J. (Michigan State Univ., East Lansing). Phys. Lett.; 31B: 433-5(30 Mar 1970).

A new method to find the wave functions and binding energy of the three nucleon system is discussed. Results of the calculations with local, central potentials are given. The wave functions are found to be sensitive to the shape of the nucleon–nucleon potential. The corresponding binding energies differ by less than 0.6 MeV. (auth)

43482 TRITON BINDING ENERGY CALCULATIONS WITH THE HAMADA–JOHNSTON POTENTIAL. Humberston, J. W.; Hennell, M. A. (University Coll., London). Phys. Lett.; 31B: 423-5(30 Mar 1970).

The triton binding energy is calculated variationally for the Hamada–Johnston potential. Investigations of the convergence of the energy with respect to systematic improvements in the trial function suggest that the fully converged energy is −6.3 ± 0.5 MeV. (auth)

43483 INTERNAL BREMSSTRAHLUNG IN THE PION-CHARGE-EXCHANGE REACTION AND THE REACTION MECHANISM. Janouch, F.; Mach, R. (Nuclear Research Inst., Rez, Czech.). Phys. Rev. Lett.; 25: 461-3(17 Aug 1970).

The threshold singularities of internal bremsstrahlung spectrum in the pion-charge-exchange reaction are used for the identification of the reaction mechanism. (auth)

43484 DIFFERENTIAL CROSS SECTIONS AND POLARIZATION IN (d,p) REACTIONS FROM THE WBP MODEL. Pearson, C. A. (Univ. of Arizona, Tucson); Bang, J. M.; Pocs, L. Ann. Phys. (N. Y.); 52: 33-58(Mar 1969).

Differential cross sections and proton polarization in (d,p) reactions predicted from the weakly-bound projectile model with nonspherical capturing interaction are compared with experiment for reactions with l_n ranging from 0 to 3. The calculations use standard nucleon–nucleus optical model parameters. The agreement found confirms the agreement found confirms the main features of the WBP mechanism, and suggests that the model may be useful for extracting values for l_n, j_n and accurate spectroscopic factors. (auth)

43485 EXTENSION OF THE THEORY OF INTERMEDIATE STRUCTURE. Iachello, Franco (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N. Y.); 52: 16-32(Mar 1969).

An extension of the intermediate-model formalism is discussed, which applies to any scattering problem in which the entrance channel couples directly, not only to the doorway states but also to "compound-nucleus" states. A detailed expression for the average scattering amplitude is obtained, and the consistency of the formalism is shown by proving that the condition $|\langle S\rangle|^2 \leq 1$ is always satisfied. (auth)

43486 ON THE CALCULATION OF MATRIX ELEMENTS OF ONE-BODY OPERATORS IN MANY-NUCLEON SYSTEMS. Werner, Ernst; Emrich, Kurt (Technische Univ., Hanover). Z. Phys.; 236: 464-86(1970).

The connection between matrix elements of one-body operators

in odd nuclei and vertex functions is demonstrated. The procedure is free of assumptions on the pole distribution of the two point functions and it does not use perturbation theory. The renormalization of the external field, necessitated by configuration space limitations, is carried through for scalar, local fields, acting on the density and for radiation fields of the electric multipole type using the requirement of gauge invariance. It is shown that this renormalization is possible, even if the renormalized field is strongly energy dependent due to configuration mixing. (auth)

43487 EQUIVALENT LOCAL POTENTIALS DERIVED FROM HARTREE-FOCK CALCULATIONS. Coz, Marcel; MacKellar, Alan D.; Arnold, Louis G. (Univ. of Kentucky, Lexington). Ann. Phys. (N. Y.); 58: 504-28(Jun 1970).

Two potentials are called equivalent if they give the same asymptotic phase shift for elastic scattering. A study was made of the equivalent potentials (ELP) derived from nonlocal potentials produced by Hartree–Fock (HF) and Brueckner–Hartree–Fock calculations. The methods used to derive these ELP are analytic. Application has been made to low energy elastic scattering from closed shell nuclei. Both the ELP and the damping function vary slowly with energy within the range from 0 to 6 MeV. The range of the ELP increases with A in approximate agreement with the nuclear size, but the functional form becomes less smooth, an effect most likely due to truncation effects in the original HF calculation. (auth)

43488 STUDY OF DEUTERON STRIPPING REACTION BY COUPLED CHANNEL THEORY. II. PROPERTIES OF INTERACTION KERNEL AND METHOD OF NUMERICAL SOLUTION. Ohmura, Takashi (Nihon Univ., Tokyo); Imanishi, Bunryu; Ichimura, Munetake; Kawai, Mitsuji. Progr. Theor. Phys. (Kyoto); 43: 347-74(Feb 1970).

The basic equations of the coupled channel method for (d, p) reactions derived in a previous paper, I [T. Ohmura, B. Imanishi, M. Ichimura and M. Kawai, Prog. Theor. Phys. 41 (1969), 391], are transformed into forms which are convenient for practical calculations in which the interaction kernels are symmetric with respect to channels. The calculated S-matrix is then also shown to be symmetric, despite the presence of the imaginary part of the optical potentials. An explicit form of the interaction kernel is given and some numerical examples are presented. The properties of the kernel are discussed in detail. The method of numerical solution of the basic equations is described in detail and examples of the calculated cross section are presented. In the calculations the non-orthogonality term in the interaction kernel is neglected. Rather detailed discussions are given on the Pauli principle between the participating nucleons. It is shown that the effect of the Pauli principle is expressed in a certain approximation by a multiplication of the interaction kernel by the square root of the spectroscopic factor. (auth)

43489 ISOSPIN PROJECTED FBCS WAVEFUNCTION FOR LIGHT NUCLEI. Ahn, S. (Technische Hochschule, Munich). Z. Phys.; 235: 244-53(1970).

Two equivalent isospin projection methods are proposed and applied to a conventional FBCS wavefunction, thus obtaining a F_{NT}BCS one. To test the effect of the projection the FBCS and F_{NT}BCS wavefunctions are compared with an exact shell model one. Practical calculations are carried out for ^{6}He using the Volkov's semirealistic potential and the first 3 major shells. Results of the calculations show that a) the F_{NT}BCS with 5 free parameters is capable of approximating the shell model wavefunction with 87 parameters and b) the FBCS results differ little from the F_{NT}BCS ones in this special case, what should be caused by the Pauli principle and the large energy spacing $\hbar\omega$. (auth)

43490 THEORY OF 2-NUCLEON-TRANSFER REACTIONS. Kragler, R.; Fick, D. (Univ., Erlangen, Ger.). Z. Phys.; 235: 271-87(1970).

The formalism of 2-nucleon-transfer reactions developed by Glendenning and Lin is slightly generalized using a cluster-model description for incoming and outgoing particles in a consistent way. The choice of an adequate spin-dependent nucleon-nucleon interaction of Gaussian radial form permits an analytic evaluation of the intrinsic matrix element. A relative s-state motion for the nucleon pair transferred leads to an additional restriction of the reaction model. Further, the polarization of outgoing particles is derived from the general structure of the T-matrix element. If spin-orbit interaction is neglected polarization effects are only expected for the transfer of unlike nucleon pairs. (auth)

43491 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON PROPERTIES OF NUCLEAR STATES, MONTREAL, CANADA, AUGUST 25–30, 1969. Harvey, M.; Cusson, R. Y.; Geiger, J. S.; Pearson, J. M. (eds.). Montreal; Les Presses de l'Universite de Montreal (1969). 828p. (In French and English). (CONF-690804).

Separate abstracts were prepared for 26 of the 27 invited papers. The remaining paper was previously abstracted in NSA. The 365 contributed papers are listed by title only. (J.W.R.)

For abstracts of individual papers see: 41688, 42384, 42873, 42913, 43109–43116, 43129–43182, 43206–43305, 43341–43456, and 43492–43600.

43492 A GENERALIZED TREATMENT OF THE ROTATION-PARTICLE COUPLING IN ODD-MASS AXIALLY-SYMMETRIC NUCLEI. Chernei, M. I.; Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 1 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43493 THEORY OF ANGULAR MOMENTUM DISTRIBUTIONS IN PRIMARY FISSION FRAGMENTS. Norenberg, W. (Univ., Heidelberg); Rasmussen, J. O.; Mang, H. J. pp 5 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43494 CRITIQUE OF NUCLEAR MODELS. Vogt, E. (Univ. of British Columbia, Vancouver). pp 5-33 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

Some problems facing conventional nuclear models, such as the shell and collective models, are discussed. Some corrections to the shell model from correlations are outlined. Some phenomena beyond the scope of the shell model, such as α-particle threshold states in light nuclei, are described. (auth) (Canada)

43495 FIXED-PARTICLE-NUMBER CORRECTIONS TO CRANKING THEORY OF NUCLEAR ROTATION. Ma, C. W.; Rasmussen, J. O. (Yale Univ., New Haven). pp 6 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43496 QUASIPARTICLE–PHONON INTERACTION IN DEFORMED NUCLEI. Weller, F. (Kernforschungszentrum, Karlsruhe, Ger.). pp 11 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43497 COMPARISON OF CRANKING MODEL WITH CORRECTIONS AND CENTRIFUGAL STRETCHING MODEL. Sood, P. C. (Banaras Hindu Univ., India). pp 12 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43498 CORIOLIS DECOUPLING IN THE ROTATIONAL MODEL. Cusson, R. Y. (Chalk River Nuclear Labs., Ont.). pp 19 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43499 TWO-FLUID MODEL OF NUCLEAR ROTATIONS. Rowe, D. J. (Univ. of Toronto). pp 27 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43500 DESCRIPTION OF COLLECTIVE MOTION WITH ANGULAR PROJECTION. Frauendorf, S.; Janssen, D.; Muenchow, L. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). pp 35 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43501 ADVANCES IN EXPERIMENTAL TECHNIQUES. Gove, H. E. (Univ. of Rochester, N. Y.). pp 35-59 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).

See CONF-690804.

The research programs that can be carried out with proposed high energy heavy ion facilities are discussed. These include such areas as the search for predicted super heavy islands of nuclear stability in the vicinity of Z = 114 and N = 184, studies of Coulomb distortion, Coulomb excitation, static moments, shape isomers and fission. The use of high energy heavy ions in other fields of physics is also noted. (auth) (Canada)

43502 OCTUPOLE STATES OF EVEN–EVEN NUCLEI IN THE RANGE $150 \leq A \leq 176$. Fedotov, S. I.; Soloviev, V. G.; Malov, L. A. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 38 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43503 SPIN-VIBRATIONAL 1^+ STATES IN DEFORMED NUCLEI. Gabrakov, S.; Kuliev, A. A.; Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 39 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43504 COORDINATE TRANSFORMATIONS USEFUL FOR THE DESCRIPTION OF COLLECTIVE STATES. Gupta, Vijay; Skinner, Ray (Univ. of Saskatchewan, Saskatoon). pp 40 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43505 STRUCTURE OF ANOMALOUS COUPLING STATES AS NEW COLLECTIVE MODES IN SPHERICAL ODD NUCLEI. Hasegawa, M.; Marumori, T.; Matsuyanagi, K. (Kyushu Univ., Fukuoka). pp 41 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43506 ROTONS IN NUCLEAR THEORY. Mikhailov, I. N. (Joint Inst. for Nuclear Research, Dubna, USSR); Nadjakov, E. pp 42 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43507 A NEW THEORETICAL METHOD FOR THE STUDY OF THE PHASE TRANSITION FROM SPHERICAL TO DEFORMED NUCLEI. Dreizler, R. M.; Klein, A. (Univ. of Pennsylvania, Philadelphia). pp 47 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43508 PHENOMENOLOGICAL STUDY OF NUCLEAR VIBRATION. Ogata, H. (Univ. of Windsor, Ont.); Akiyama, Y. pp 49 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43509 RADIOCHEMICAL STUDIES OF LOW-LYING OPPOSITE PARITY STATES IN VIBRATIONAL AND TRANSITIONAL NUCLEI. Walters, W. B.; Gordon, G. E.; Coryell, C. D. (Massachusetts Inst. of Tech., Cambridge). pp 52 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43510 BOOTSTRAP EQPC, RPA, AND THE ODD–EVEN MASS DIFFERENCE. Goswami, A. (Univ. of Oregon, Eugene); Nalcioglu, O.; Sherwood, A. I. pp 59 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43511 THE PAIRING COLLECTIVE DEGREE OF FREEDOM. Bes, D. R.; Broglia, R. A.; Perazzo, P. J. (Univ. of Minnesota, Minneapolis). pp 60 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43512 NUCLEAR SATURATION, ROTATIONAL INVARIANCE AND MICROSCOPIC THEORIES OF THE NUCLEAR MOMENT OF INERTIA. Ng, W. Y.; Trainor, L. E. H. (Univ. of Toronto). pp 63 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43513 NUCLEI WITH COLLECTIVE PROPERTIES. Elbek, B. (Niels Bohr Inst., Copenhagen). pp 63-84 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

The applicability of the Nilsson model is greatly extended if the effects of pairing, Coriolis and $\Delta N = 2$ couplings are systematically taken into account. Measured E2-transition probabilities from states in ground, beta and gamma bands in even nuclei show the influence of strong mutual couplings but no quantitative analysis has yet been entirely successful. Systematic features of the octopole bands in deformed nuclei are ascribed to strong Coriolis couplings. (auth) (Canada)

43514 NEW MICROSCOPIC APPROACH TO ROTATIONAL EXCITATIONS. Belyaev, S. T.; Zelevinskii, V. G. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 65 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43515 THE RELATION BETWEEN $\Delta < R_p^2 >$ AND $\Delta\beta_p$ IN THE NILSSON MODEL. Cusson, R. Y. (Chalk River Nuclear Labs., Ont.); Castel, B. pp 68 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43516 A MACROSCOPIC FORMULATION OF THE SYSTEMATICS OF NUCLEAR GROUND STATE CHARGE AND MATTER DISTRIBUTIONS. Carter, E. B. (Trinity Univ., San Antonio). pp 69 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43517 COULOMB INTERACTION IN FAST PROTON RADIATIVE CAPTURE. Longo, G.; Saporetti, F. (Comitato Nazionale Energia Nucleare, Bologna). pp 70 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43518 INFLUENCE OF SHORT RANGE CORRELATIONS ON LONG RANGE EFFECTS: NUCLEAR CHARGE DISTRIBUTION. Danos, Michael; Gibson, Benjamin F. (National Bureau of Standards, Washington, D. C.). pp 71 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43519 COMPETITION BETWEEN PROLATE AND OBLATE SHAPES IN THE A = 190 REGION. Kumar, Krishna (Univ. of Copenhagen). pp 82 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43520 NUCLEAR DEFORMATIONS IN THE $28 < Z < 50$, $50 < N < 82$ REGION. Soloviev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR); Arseniev, D. A.; Sobiczewski, A. pp 84 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43521 TRANSITIONAL NUCLEI. Sorensen, R. A. (Carnegie-Mellon Univ., Pittsburgh). pp 85-107 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

This rapporteur talk describes recently developed methods to treat models of quadrupole and pairing, through the transition to

deformation. Centrigufal stretching model results are reviewed including also the two fluid models. Particle-core models are treated for weak and strong coupling, including self consistent methods. Finally M1 collective effects are mentioned. (auth) (Canada)

43522 SHAPES OF NUCLEI. Barrett, R. C. (Univ. of Surrey, Sutton, Eng.). pp 109-23 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.
Different methods for obtianing the neutron radius give conflicting results. We no longer need an angular variation in the skin thickness of deformed nuclei. We can now understand better what characteristics of the radial charge distribution are being determined by muonic X-rays and electron scattering. (auth) (Canada)

43523 PHENOMENOLOGICAL DETERMINATION OF EXCHANGE CURRENTS BY PHOTON AND ELECTRODISINTEGRATION OF NUCLEI. Bosco, B. (Univ., Cagliari, Italy. International Centre for Theoretical Physics, Trieste). pp 115 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43524 THE EFFECT OF GENERALIZED DEFORMATIONS ON MONOPOLE ELASTIC ELECTRON SCATTERING. Raphael, R. B. (The Catholic Univ. of America, Washington, D. C. Naval Research Lab., Washington, D. C.); Rosen, M. pp 117 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43525 WEAK INTERACTION VECTOR COUPLING CONSTANT IN BETA DECAY. Freeman, J. M. (Atomic Energy Research Establishment, Harwell, Eng.); Robinson, D. C.; Wick, G. L.; Thwaites, T. T.; Burcham, W. E. pp 140 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43526 NEW REGIONS OF STABILITY. Nilsson, S. G. (Lund Inst. of Tech., Sweden). pp 149-74 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.
The oscillator model with P_2 and P_4 deformations is used to obtain shell model corrections to the hydrodynamic model of fission. This method due to Strutinsky predicts the existence of superheavy isotopes in Z = 114 region. (auth) (Canada)

43527 A MICROSCOPIC QUANTITATIVE DESCRIPTION OF (p,p') SCATTERING BY THE D.W.B.A. WITH ANTISYMMETRIZATION. Schaeffer, R. (CEN, Saclay, France). pp 152 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43528 SELF-CONSISTENT PARTICLE ENERGIES AND THREE-BODY CLUSTERS IN NUCLEAR MATTER CALCULATIONS. Kao, H. W.; Depp, J.; McCarthy, R. J.; Baranger, M. (Carnegie-Mellon Univ., Pittsburgh). pp 158 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43529 NUCLEAR FORCES AND MESON-EXCHANGE. Erkelenz, K.; Holinde, K.; Bleuler, K. (Univ., Bonn). pp 159 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43530 EXISTENCE OF A VERY SOFT CORE NUCLEON–NUCLEON LOCAL STATIC POTENTIAL. Sprung, D. W. L.; Srivastava, M. K. (McMaster Univ., Hamilton, Ont.). pp 161 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43531 ONE-BOSON-EXCHANGE POTENTIALS AND NUCLEAR MATTER. Richards, K. C.; Haftel, M. I.; Tabakin, F. (Univ. of Pittsburgh). pp 162 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43532 NUCLEAR MATTER PROPERTIES OF THE BOUNDARY CONDITION MODEL. Lomon, E. L. (Massachusetts Inst. of Tech., Cambridge). pp 165 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43533 ISOBAR INTERMEDIATE STATE CONTRIBUTIONS TO THE NUCLEON–NUCLEON POTENTIAL. Lomon, Earle L.; Partovi, M. Hossein (Massachusetts Inst. of Tech., Cambridge). pp 166 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43534 NUCLEON–NUCLEON POTENTIAL AND MINIMAL RELATIVITY. Brown, G. E.; Jackson, A. D.; Kuo, T. T. S. (State Univ. of New York, Stony Brook). pp 167 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43535 PHENOMENOLOGY OF EFFECTIVE OPERATORS. Khanna, F. C.; Harvey, M. (Chalk River Nuclear Labs., Ont.). pp 168 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43536 THIRD-ORDER TERMS IN THE BLOCH–HOROWITZ–BRANDOW EXPANSION FOR THE EFFECTIVE INTERACTION IN FINITE NUCLEI. Barrett, B. R. (Univ. of Pittsburgh); Kirson, M. W. pp 170 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43537 PROPERTIES OF N = Z CLOSED SHELL NUCLEI AND OF THE NUCLEAR SURFACE FOR A SIMPLE EFFECTIVE INTERACTION. Moszkowski, S. A. (Univ. of California, Los Angeles). pp 171 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43538 A SEPARABLE POTENTIAL MODEL FOR NUCLEAR HARTREE–FOCK CALCULATIONS. Hammann, T. F.; Ho-Kim, Q. (Univ., Laval, Quebec). pp 172 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43539 SEMI-REALISTIC EFFECTIVE SHELL-MODEL INTERACTIONS. Saunier, Gerard; Pearson, J. M. (Univ., Montreal). pp 176 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43540 EFFECTIVE INTERACTION DETERMINED FROM THE SCATTERING AMPLITUDE. Hodgson, R. J. W.; Razavy, M. (Univ. of Alberta, Edmonton). pp 179 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43541 DISPERSION RELATION APPROACH TO THE NUCLEAR STRUCTURE CALCULATION. Razavy, M.; Hodgson, R. J. W. (Univ. of Alberta, Edmonton). pp 180 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43542 OFF-ENERGY-SHELL CONTINUATION OF THE TWO-NUCLEON TRANSITION MATRIX. Baranger, M.; Giraud,

B.; Mukhopadhyay, S. K.; Sauer, P. U. (Carnegie-Mellon Univ., Pittsburgh). pp 181 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43543 A NEW APPROXIMATION TO THE BETHE–GOLDSTONE WAVE FUNCTION. Butler, S. T.; Hewitt, R. G. L.; McKellar, B. H. J.; Nicholls, I. R.; Truelove, J. S. (Univ. of Sydney). pp 182 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43544 CONTINUOUS-SPECTRUM ASPECTS AND FINITE-RANK STRUCTURE OF A SELF-CONSISTENT NUCLEAR POTENTIAL. Stingl, M.; Kirson, M. W. (Weizmann Inst. of Science, Rehovoth, Israel). pp 183 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43545 SECOND-ORDER CORRECTIONS TO EFFECTIVE CHARGES. Dieperink, A. E. L.; Brussaard, P. J. (Rijksuniversiteit, Utrecht). pp 184 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43546 MANY BODY THEORY OF THE EFFECTIVE FORCE TO BE USED IN THE DWBA. Gross, D. H. E. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). pp 185 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43547 GALILEI AND TRANSLATIONALLY (G. T.) INVARIANT SPIN-ORBIT INTERACTION. Aviles, J. B. Jr. (Naval Research Lab., Washington, D. C.). pp 191 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43548 NUCLEAR ROTATIONAL BANDS: SU(3) VS. SL(3,R). Weaver, O. L.; Biedenharn, L. C. (Duke Univ., Durham, N. C.). pp 194 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43549 A CALCULATION METHOD FOR THE MULTIPLICITY OF STATES. Nomura, M. (Tokyo Univ.). pp 198 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43550 THE MASS SYSTEMATICS OF THE 2s-1d SHELL ANALYSED BY THE AVERAGE ENERGY METHOD. Ichimura, Munetake (Tokyo Univ.). pp 205 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43551 SOLUTION OF THE NUCLEAR THREE BODY PROBLEM IN COORDINATE SPACE. Borysowicz, J. (Michigan State Univ., East Lansing). pp 208 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43552 RESIDUAL INTERACTION AND THE SENIORITY SCHEME OF THREE- AND FOUR-NUCLEONS IN A SINGLE SHELL. Nomura, M. (Tokyo Univ.). pp 211 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43553 SPECTRAL MEASURES FOR SPACE SYMMETRY IN LIGHT NUCLEI. Parikh, J. C. (Univ. of Rochester, N. Y.). pp 212 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43554 CORIOLIS-COUPLING MODEL CALCULATIONS FOR SD SHELL NUCLEI. Hirko, R. G.; Bromley, D. A. (Yale Univ., New Haven). pp 216 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43555 RELATIONS AMONG SHELL MODEL SPECTRA INCLUDING MANY-BODY EFFECTIVE INTERACTIONS. Koltun, D. S.; West, B. J. (Univ. of Rochester, N. Y.). pp 218 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43556 SHELL MODEL CALCULATION IN LARGE j CONFIGURATION. Nomura, M. (Tokyo Univ.). pp 219 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43557 TRANSITION MATRIX ELEMENTS FROM ELECTROMAGNETIC INTERACTIONS. Broude, C. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 221-44 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.
Conference contributions on developing experimental angular correlation techniques and lifetime measurements are described. A review of lifetime measurements by Doppler shift attenuation is given with particular reference to the uncertainties in deriving heavy ion stopping cross sections. Some experimental evidence is given for a dependence of experimental lifetimes derived from D. S. A. M. on the characteristic stowing time of the stopping material. (auth) (Canada)

43558 GENERALIZATION OF THE RELATION BETWEEN THE SYMPLETIC AND QUASISPIN GROUPS. Moshinsky, M.; Quesne, C. (Univ., Mexico City. Comision Nacional de Energia Nuclear, Mexico City). pp 224 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43559 EQUIVALENCE OF RECENT MICROSCOPIC THEORIES OF COLLECTIVE MOTION. Klein, Abraham (Univ. of Pennsylvania, Philadelphia); Dreizler, R. M.; Johnson, Robert E. pp 234 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43560 SELFCONSISTENT THEORY OF NUCLEAR CORRELATIONS. Faessler, A.; Plastino, A. (Univ., Muenster, Ger.). pp 237 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43561 ISOTOPIC SPIN MIXING OF HARTREE–FOCK SOLUTIONS. Brink, D. M.; Svenne, J. P. (Institut de Physique Nucleaire, Orsay, France). pp 238 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43562 MIXED PARITY HARTREE-FOCK CALCULATIONS USING REALISTIC FORCES. Ullah, Nazakat; Wong, S. S. M. (Univ. of Toronto). pp 239 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43563 DEFINITION OF THE SINGLE-PARTICLE POTENTIAL. Baranger, M. (Carnegie-Mellon Univ., Pittsburgh. Oak Ridge National Lab., Tenn.). pp 240 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43564 A NON-SINGULAR LOCAL NUCLEON–NUCLEON POTENTIAL FOR HARTREE–FOCK CALCULATIONS. Pires, P.; De Tourreil, R. (Institut de Physique Nucleaire, Orsay, France). pp 244 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43565 ROLE OF INELASTIC PROCESSES IN TWO-NUCLEON TRANSFER REACTIONS. Glendenning, N. K. (Univ. of California, Berkeley). pp 245-61 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.
Calculations show that the effect of inelastic collisions on transfer reactions is quite large even in a nucleus which is not strongly collective. The DWBA is in error in relative cross sections for this reason by as much as a factor of three. At a typical bombarding energy of 30 MeV for the ^{62}Ni (p,t) reaction, no special features in the angular distribution nor polarization distinguish second-order from direct transfer processes. (auth) (Canada)

43566 RESTORATION OF ROTATIONAL SYMMETRY FOR TRIAXIAL HARTREE–FOCK SOLUTIONS. Giraud, B.; Sauer, P. U. (Carnegie-Mellon Univ., Pittsburgh). pp 246 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43567 RESULTS OF CALCULATIONS WITH UNIFIED MODEL PEIERLS–YOCCOZ WAVE FUNCTIONS. Sharon, Y. Y. (Northeastern Univ., Boston). pp 247 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43568 A NEW FORMULA FOR THE PROTON OPTICAL POTENTIAL. Hodgson, P. E. (Nuclear Physics Lab., Oxford). pp 252 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43569 THE REAL PART OF THE OPTICAL MODEL POTENTIAL AT 30 AND 50 MeV. Thomas, G. L. (King's Coll., London). pp 255 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43570 DEFORMATION OF SPIN-ORBIT POTENTIAL IN COUPLED EQUATIONS. Raynal, J. (CEN, Saclay, France). pp 261 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43571 BASIC NUCLEON–NUCLEON INTERACTION. Brueckner, K. A. (Univ. of California, La Jolla). pp 265-75 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.
A review is made of the different methods for treating the two-nucleon interaction. A discussion of the phenomenological and the one boson exchange (OBE) methods is given. The application of the second method to the nuclear many-body problem has shown that it is possible to describe complex nuclei using two-body interactions. (auth) (Canada)

43572 A NUMERICAL STUDY OF THE VALIDITY OF DWBA FOR (d,p) REACTIONS. Ichimura, M. (Tokyo Univ.); Imanishi, B.; Kawai, M. pp 266 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43573 DEUTERON STRIPPING REACTIONS BELOW THE COULOMB BARRIER. Alder, K.; Trautmann, D. (Univ. of Basel). pp 275 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43574 EFFECTIVE INTERACTIONS. Elliott, J. P. (Univ. of Sussex, Brighton, Eng.). pp 277-91 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.
The definition of an effective interaction as the sum of the bare interaction and the perturbation corrections is first explained. The success of energy-level calculations with effective interactions derived from the Tabakin potential, from the Hamada–Johnson potential and from the phase-shifts is described. A few contributed papers are discussed. (auth) (Canada)

43575 POTENTIAL CONCEPT IN NUCLEON–NUCLEON INTERACTIONS AND LIMITATIONS OF EXISTING MODELS. Breit, G. (State Univ. of New York, Buffalo). pp 293-307 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.
After a brief mention of pre-Yukawa exchange potentials and an enumeration of weaknesses of phenomenological phase-parameter analyses, the position of hard-core and soft-core potentials in the field is described. The one-boson exchange potentials and related approaches are then discussed with the conclusion that there are serious doubts regarding their applicability. (auth) (Canada)

43576 NUCLEAR PARENTAGE SIMPLY OBTAINED FROM TWO-NUCLEON TRANSFER REACTIONS. Hardy, J. C.; Brunnader, H.; Cerny, Joseph (Univ. of California, Berkeley). pp 303 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43577 SHELL MODEL. Harvey, M. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 313-36 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.
The shell model is reviewed with an emphasis on the essential features. The possibility of vibrations in the sd-shell and their causes is discussed. A brief review of the status of effective-charge calculations is given. (auth) (Canada)

43578 ANALOG RESONANT EFFECTS IN DEUTERON STRIPPING. de Toledo Piza, A. F. R. (Univ., Sao Paulo, Brazil). pp 314 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43579 FINE STRUCTURE ANALYSIS OF ISOBARIC ANALOG RESONANCES (IAR). DiToro, M. (Massachusetts Inst. of Tech., Cambridge. Univ., Catania, Italy). pp 325 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43580 DESCRIPTION OF PAIRING VIBRATIONAL STATES. Mihailovic, M. V.; Justin, D.; Rosina, M. (Univ. of Ljubljana, Yugoslavia). pp 335 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43581 THEORETICAL ANALYSIS OF NUCLEAR SPECTROSCOPIC DATA WITHIN THE QUASI-PARTICLE UNIFIED NUCLEAR MODEL. Choudhury, D. C.; Clemens, J. T. (Polytechnic Inst., Brooklyn, N. Y.). pp 337 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43582 INDEPENDENT PARTICLE MODEL IN THE LEAD REGION. Stein, N. (Yale Univ., New Haven). pp 337-63 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey,

M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.
Nuclear structure in the lead region is discussed in terms of the shell model. The single-particle structure with respect to the ^{208}Pb core is summarized and then extended to other nuclei in the lead region. The coupling of single-particle with core excitations to reach highly excited states is also described. (auth) (Canada)

43583 QUARTET MODEL APPLIED TO 4 PARTICLE-4 HOLE EXCITATIONS. Jaffrin, A. (CEN, Saclay, France). pp 338 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43584 MIXED COUPLING EXTENDED TO PAIRS FOR A SYSTEM OF NEUTRONS AND PROTONS. Raynal, J. (CEN, Saclay, France). pp 339 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43585 ON THE CONTRIBUTION OF THE COHERENT RPA MODES TO THE GROUND STATE CORRELATIONS. Providencia, J. (Universidade de Coimbra, Portugal). pp 341 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43586 THE DETERMINATION OF THE PARTICLE-HOLE EXCITED STATES BY USING THE VARIATIONAL APPROACH FOR THE GROUND STATE TWO-BODY DENSITY MATRIX. Mihailovic, M. V.; Rosina, M. (Univ. of Ljubljana, Yugoslavia). pp 346 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43587 STRUCTURE OF THE NUCLEON–NUCLEUS SCATTERING MATRIX IN THE RANDOM-PHASE APPROXIMATION. Ginocchio, J. N.; Schucan, T. H.; Weidemueller, H. A. (Yale Univ., New Haven). pp 355 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43588 SPECTROSCOPY OF UNBOUND LEVELS THROUGH A UNIFIED REACTION THEORY USING WEINBERG'S QUASI-PARTICLES. Huby, R. (Univ., Liverpool). pp 357 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See Conf-690804.

43589 CONTINUUM CONTRIBUTIONS TO SPECTROSCOPIC FACTOR SUM RULES. McKellar, B. H. J. (Univ. of Sydney). pp 359 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43590 TREATMENT OF THE CONTINUUM–CONTINUUM INTERACTION BY THE FACTORIZATION APPROXIMATION IN COUPLED CHANNEL THEORY. Nguyen Van Giai; Marty, C. (Institut de Physique Nucleaire, Orsay, France). pp 363 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.

43591 POSSIBLE DYNAMICAL RESTRICTIONS ON THE STRENGTH FUNCTION OF NUCLEAR REACTION THEORY. Mello, P. A. (Univ. of Mexico, Mexico City); de Llano, M.; Feshbach, H. pp 364 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

43592 SELF-CONSISTENT CALCULATIONS FOR GROSS NUCLEAR PROPERTIES. Kerman, A. K. (Massachusetts Inst. of Tech., Cambridge). pp 365–81 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.
A review of types of self consistent calculations and the types of forces that can be used in such calculations with particular emphasis on the Hartree–Fock studies for gross nuclear properties. (auth) (Canada)

43593 PROPERTIES OF THE PARTIAL RADIATION WIDTHS OF BOUND NUCLEAR LEVELS EXCITED BY THE $(\gamma\gamma')$ REACTION. Ben-David, G.; Schlesinger, Y. (Soreq Nuclear Research Centre, Yavne, Israel. Bar Ilan-Univ., Ramat Gan, Israel). pp 366 of Contributions to the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-69084.

43594 SINGLE-NUCLEON TRANSFER REACTIONS. MacFarlane, M. H. (Argonne National Lab., Ill. Univ. of Chicago). pp 385–420 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.
The one-nucleon-transfer reactions are discussed using the DWBA. Two new directions in the recent developments are emphasized: 1) the use of polarized beams to determine the spin dependence of optical potentials; 2) the improved treatment of single particle radial form factors. The contributions and other recent papers on this subject are also discussed. (auth) (Canada)

43595 SPECTROSCOPIC INFORMATION FROM FEW PARTICLE TRANSFER REACTIONS. Hansen, O. (Los Alamos Scientific Lab., N. Mex.). pp 421-41 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.
The microscopic and macroscopic approaches to the analysis of two-nucleon transfer-reactions are outlined and a number of examples of each method are given. In particular the pairing-rotational and pairing-vibrational models are presented and discussed in some detail, and new data from (t,p) and (^{3}He,p) reactions are used as illustrations. The experimental status of Li-induced α-transfer reactions is critically evaluated. (auth)

43596 ISOBARIC ANALOGUE STATES. Hanna, S. S. (Stanford Univ., Calif.). pp 443–80 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.
The analog levels in light nuclei are summarized. The allowed and forbidden properties of these levels are discussed. The beta and gamma analogs are compared. The E1 analog in the mass 90 region are examined in relation to the over-all E1 strength. The E1 resonances observed in the N = 82 region and the Pb region are presented. Certain features of the charge exchange reaction (^{3}He,t) are discussed. Recent analyses of the shapes and angular distributions of elastic and inelastic analog resonances are summarized. (auth) (Canada)

43597 BOUND AND UNBOUND MANY-QUASIPARTICLE STATES. Gillet, V. (CEN, Saclay, France). pp 483-514 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969). (In French).
See CONF-690804.
Some aspects of many-particle, many-hole states in light nuclei are discussed. The circumstantial evidence for the existence of such states in spherical medium and heavy nuclei are reviewed. Finally the role of many-quasiparticle states in the fine structure of the giant resonance is examined. (auth) (Canada)

43598 CONTINUUM AND NUCLEAR STRUCTURE. Weidenmuller, H. S. (Univ., Heidelberg). pp 529-48 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.
The influence of the continuum on nuclear structure is discussed. By nuclear structure we mean that part of nuclear physics which can be understood using bound state models. The range and limitations of the present treatments of the continuum are sketched. Examples are given where the continuum has an influence on nuclear structure. (auth) (Canada)

43599 HEAVY-ION INTERACTIONS. Bromley, D. A. (Yale Univ., New Haven). pp 571-90 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

Heavy ion scattering cross sections show striking and unexpected energy dependence at energies well in excess of the Coulomb barriers. These studies show promise of providing new and perhaps unique, information on both the interaction potentials and the low excitation structure of the interacting ions; they emphasize the importance of precision energy control in heavy ion physics. (auth) (Canada)

43600 RECENT RESULTS IN CONSTRAINED HARTREE–FOCK CALCULATIONS. Le Tourneux, J. (Univ. of Montreal). pp 591-601 of Proceedings of the International Conference on Properties of Nuclear States, Montreal, Canada, August 25–30, 1969. /Harvey, M. (ed.). Montreal; Les Presses de l'Universite de Montreal (1969).
See CONF-690804.

Results are presented for some recent calculations done for various s-d shell nuclei by the constrained Hartree–Fock method. An approximate variation-after-projection method is described. A modified Hartree–Fock equation which allows unstable solutions is presented. Several branches exist for the energy as a function of the quadrupole moment taken as the generator coordinate in the Hill–Wheeler method. (tr-auth)

43601 EFFECT OF NONORIENTED NUCLEI ON ELASTIC SCATTERING OF ALPHA PARTICLES. Yushkov, A. V. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat., No. 6, 24-9(Nov.-Dec. 1968). (In Russian).

The influence of nuclear deformation on measurements of the nuclear radius and surface thickness was studied. It was found that the determination of R and ΔR from alpha elastic scattering data by diffraction theory is noticeably affected by the nonorientation of target nuclei. This effect causes an increase in ΔR and a decrease in R. This effect puts into question calculations for R and ΔR based on the neutron and proton numbers. (J.W.R.)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstract 42304.

43602 (CEA-N-1302) BUGEY GAP MODEL. Bourdet, Lucien; Dufreche, Francis; Oceraies, Yves (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1970. 85p. (In French). Dep. CFSTI (U. S. Sales Only).

The results obtained during the experiments on neutron and gamma fluxes through the Bugey upper axial air gaps are presented. Three configurations were studied: empty gaps, gaps with an assembly of 36 steel tubes extending the channels, gaps with 36 tubes filled with fiber glass. (auth) (France)

43603 (CEA-N-1305) STATIONARY DOSE UNDER A TUBULAR BASE PLATE OF THE FESSENHEIM TYPE. Duco, Jacques; Guezenec, Jean-Yves; Oceraies, Yves (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1970. 33p. (In French). Dep. CFSTI (U. S. Sales Only).

The interpretation of neutron and γ measurements made on the Fessenheim-type base-plate mockup at Naïade-2 provides methods of calculation that are applicable to the reactor for evaluating the dose due to the activation of the metallic structures (Co) and due to the fission products under the base-plate. (4 references) (auth) (France)

43604 (FRIGG-3) HYDRODYNAMIC AND HEAT TRANSFER MEASUREMENTS ON A FULL-SCALE SIMULATED 36-ROD MARVIKEN FUEL ELEMENT WITH NON-UNIFORM RADIAL HEAT FLUX DISTRIBUTION. Nylund, O.; Becker, K. M.; Eklund, R.; (and others) (Aktiebolaget Atomenergi, Stockholm (Sweden). ASEA-ATOM, Vasteras (Sweden)). Nov 1969. 158p. Dep. CFSTI.

Summaries are given from the results obtained for the second 36-rod cluster having radially non-uniform heat flux distribution. Included are also the results of a few tests of existing calculation models against the measured data. The full-scale loop test program for the boiling channels of the Marviken reactor included investigations of axial and radial void distribution, single- and two-phase pressure drop, natural circulation mass velocity, stability limits as well as detailed dynamic characteristics, and burnout in natural and forced circulation. The experiments started with full length uniformly heated 6-rod and 36-rod test sections followed by a 36-rod test section with a non-uniform radial heat flux distribution. (41 references) (auth) (Sweden)

43605 (HPR-120) EARLY EXPERIENCE WITH THE AEROBALL SYSTEM. Black, W. S. A. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Feb 1970. 66p. Dep. CFSTI (U. S. Sales Only).

The aeroball system installed during the Jan.-Feb. 1969 shutdown is described and the experience from the commissioning and the first three months of use of the system is detailed. The performance of the aeroball system during this first period of use is found to be satisfactory, and the accuracy of the obtained axial form factor is steadily improving as various error sources are eliminated. Reasonable comparisons are obtained between form factor states from the later aeroball measurements and those derived from simultaneous measurements of the other types of neutron flux detectors mounted in PEI-306. Further improvements resulting from the experience are recommended and suggestions for the future uses of the system are included. (5 references) (auth)

43606 (NP-18352) DRAFT ASME CODE FOR PUMPS AND VALVES FOR NUCLEAR POWER. (American Society of Mechanical Engineers, New York). Nov 1968. 217p. ASME, New York $3.00.

The rules of the code constitute requirements for the design, materials, manufacture, examination, inspection, pressure testing and certification of pumps and valves for use in the nuclear energy system of water cooled commercial nuclear power plants. A nuclear energy system is that part of a power plant that serves the purpose of producing and controlling an output of thermal energy from nuclear fuel. The scope of these rules covers the strength and pressure integrity of the structure of pumps and valves whose failure would violate the pressure boundary. They are not intended to be applicable to valve operators, controllers, position indicators, pump impellers, pump drives or other accessories and devices, unless such items themselves are pressure parts. These rules provide requirements for new construction. They cover mechanical and thermal stresses but do not cover deterioration that may occur in service as a result of corrosion, radiation effects, and instability of material. (auth)

43607 (SGAE-RT-31/1970) NUCLEAR FUEL DEMAND FORECASTS FOR AUSTRIA. Gruemm, H.; Nathschlaeger, P. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Reaktortechnik). [1970]. 14p. (CONF-700903-1). Dep. CFSTI (U. S. Sales Only).

From 4th Foratom Congress on Industrial Aspects of the Nuclear Fuel Cycle in Europe, Stockholm, Sweden.

Predicted demands for nuclear fuels in Austria are presented for 1975 to 1990. 4 references. (D.C.C.)

43608 ATOMIC POWER IN NORWAY. Anderssen, Knut S.; Asvall, Thorstein; Ager-Hanssen, Henrik. Tek. Ukebl.; 117: 18-29(15 Jan 1970). (In Norwegian).

Following a short description of a BWR, the proposed plant arrangements for the conventional and underground installations at the two planned sites are described. Brief surveys of the operational and safety aspects are given. A corresponding survey is given for an AGR. The safety and environmental factors involved are described. The integration of atomic power in the Norwegian power supply system is discussed. The possible relationships between the utility, the main contractors, and the subcontractors are considered. Discussion of the date for introduction of atomic power production and the long term prospects of atomic power in the world perspective are presented. (J.I.W.) (Norway)

43609 FLUID FLOW MEASUREMENTS INSIDE THE REACTOR VESSEL OF THE 50 MWe DODEWAARD NUCLEAR POWER PLANT BY CROSS-CORRELATION OF THERMOCOUPLE SIGNALS. Termaat, K. P. (NV GKN, Arnhem, Netherlands). J. Phys., E (London): 3: 589-93(Aug 1970).

In the downcomer region of the reactor system of the 50 MWe Dodewaard boiling water reactor with natural circulation, 30 pairs of fast response thermocouples are used to detect temperature fluctuations in the turbulent flowing water. After amplification and filtering, the signals of each thermocouple pair are fed into a multipoint polarity coincidence correlator to form the cross correlation function $C_{12}(k\Delta\tau)$. From this function the mean transit time τ_1 of the temperature fluctuations to cover the distance l between the thermocouples is easily found. The local velocity then follows from the simple relation $V_{H_2O} = l/\tau_1$. The method has proved very useful in the determination of local fluid velocities in the range 0.15 to 1.50 m s^{-1}. From these local measurements radial and axial velocity profiles and total recirculation flow can be derived. (auth) (UK)

43610 MARVIKEN: BACKGROUND TO THE DECISIONS. Margen, P. H. (Aktiebolaget Atomenergie, Stockholm). Nucl. Eng. Int.; 15: 527-9(Jun 1970).

In explaining the decision to discontinue completion of Marviken as a BHWR, its original role in the Swedish nuclear program is reviewed. Cost of improvements which would be necessary to produce satisfactory void and fuel temperature coefficients, which are shown to be unfavorable, are discussed. Reasons are given for the decision to consider conversion to a light water reactor. (UK)

43611 PRELICENSING ANTITRUST REVIEW OF NUCLEAR POWERPLANTS. PART 2. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-FIRST CONGRESS, SECOND SESSION, APRIL 14, 15, AND 16, 1970. Washington, D. C.; Joint Committee on Atomic Energy(1970). 383p. GPO $1.50.

43612 STUDY OF CRITICAL ASSEMBLIES OF THE BELOYARSKOI NUCLEAR POWER PLANT. Akimov, I. S.; Alekseev, V. I.; Vikulov, V. ; (and others). At. Energ. (USSR); 28: 321-6(Apr 1970). (In Russian).

The reactor consists of two blocks having an electrical power of 100 and 200 MW. An experimental study of critical assemblies was carried out during the reactor startup. The effects of U enrichment, assembly geometry, water in the channels, and steel and Zr channels in the control rod system were investigated. Studies were made of neutron distributions, reactivity effects, Cd ratios with In, Au, and ^{235}U, fission rate ratios in channels of various types, and the ratio of the efficiencies of rods and channels of the control system. The effects of the horizontal experimental channels on critical assemblies of steel tubes (32 x 2 mm in size) was estimated. The probability of avoiding resonance absorption in ^{238}U, and the fast neutron breeding coefficient were measured. Calculated distribution of thermal neutrons along the radius and height of the assemblies generally agree well with the measured values. (TTT)

43613 PICKERING: CONSTRUCTION AND SITE WORK. Smuck, F. H. Nucl. Eng. Int.; 15: 516-20(Jun 1970).

Descriptions are given of the organisation of on-site work, site foundations and substructure, concrete construction of reactor buildings, calandria vaults and vacuum building, transport and installation of reactor components, and on-site pipe fabrication and welding. There are also on-site facilities for leak-testing, radiographic inspection, repair, and maintenance of mechanical equipment. The station uses computer produced cable and wiring print-outs. (UK)

43614 PICKERING GENERATING STATION. Moon, C. L. Nucl. Eng. Int.; 15: 501-5(Jun 1970).

Location and station layout of the 4 unit, 2000 MW(e) pressure-tube system are described. Details are given of the calandria, heat transport system, moderator, and fuel-handling equipment designed for on-power once-through refuelling. The negative pressure containment system, also described, comprises a common vacuum building connected to the boiler room of each reactor building. Some estimated costs are presented. (UK)

43615 MECHANICAL DESIGN OF THE PICKERING CORE. Simmonds, C. A. Nucl. Eng. Int.; 15: 508-10(Jun 1970).

Coolant channels form part of the primary heavy water system, while the calandria forms part of the separate moderator system. The arrangement of calandria vessel and reactor core is shown. Details, which include dimensions and materials, are given of the pressure tubes, end fittings, and calandria. The mechanism of reactivity control devices and the method of thermal shielding are described. (UK)

43616 PICKERING: CORE PHYSICS. Loeken, P. C. Nucl. Eng. Int.; 15: 506-7(Jun 1970).

Design details which differ from those in NPD or Douglas Point are discussed. They include increased bore of the pressure tubes, which are of Zr-2½% Nb alloy in two units, shaping of the thermal neutron flux by Co loaded adjuster rods, and the use of a zone control system to stabilise thermal neutron flux distribution. Lattice parameters for new and for equilbrium fuel, reactivity coefficients associated with changes in fuel, coolant, and moderator temperature, data pertaining to neutron economy, and characteristics of shut-down mechanisms are presented. (UK)

43617 PICKERING: STATION CONTROL. Key, F. J. Nucl. Eng. Int.; 15: 511-13(Jun 1970).

Control of all major loops is automatically carried out by means of twin digital computers. Primary long term reactivity control is by incremental refuelling. Control of power level over intermediate and short periods is by use of B_2O_5 in the moderator or by variation in the level of H_2O in 14 zone control compartments: differential use of these compartments maintains uniform flux levels. Rapid shutdown is achieved by 11 shutoff rods and by moderator dumping. Xenon override is controlled by removal of 18 Co adjuster rods. (UK)

43618 FUEL AND FUEL CYCLE. Fanjoy, G. R.; Bain, A. S. Nucl. Eng. Int.; 15: 514-15(Jun 1970).

Each reactor unit contains 4680 short bundles, length 495 mm, of UO_2 pellets clad in Zircaloy-4 sheathing. The 0.4 mm thick sheathing, giving high neutron economy, requires mechanical support from the pellets to withstand coolant pressure. Resistance welding is used for bundle assembly and for pencil end cap welds Zircaloy-4 spacers are attached to the sheath by Zr-Be braze alloy. Key fuel design and performance parameters are given. Fuel performance in NPD and Douglas Point are described. Aspects discussed are fission product release, two-phase operation, dimensional stability, and coolant chemistry. Reference is also made to the economics of the fuel cycle and the potential for a wide range of cycles. (UK)

Operation and Economics

43619 (DOCKET-1155-68) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report, April 1970. (Dairyland Power Cooperative, La Crosse, Wis.). 20 Aug 1970. Contract AT(11-1)-851. 28p. (DPC-851-10). Dep. CFSTI.

43620 (DOCKET-50016-75) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, April 1970. (Power Reactor Development Co., Detroit, Mich.). 11 Aug 1970. 10p. (PRDC-EF-80). Dep. CFSTI.

43621 (DOCKET-50016-76) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, May 1970. (Power Reactor Development Co., Detroit, Mich.). 11 Aug 1970. 8p. (PRDC-EF-81). Dep. CFSTI.

43622 (DOCKET-50029-126) YANKEE NUCLEAR POWER STATION. Operation Report No. 115, July 1970. (Yankee Atomic Electric Co., Westboro, Mass.). 20 Aug 1970. 8p. Dep. CFSTI.

43623 (DOCKET-50171-54) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 52, June 1970. (Philadelphia Electric Co., Pa.). 20 Aug 1970. 25p. Dep. CFSTI.

43624 (DOCKET-50206-84) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, May 1968. (Southern California Edison Co., Los Angeles). Jun 1968. Contract AT(30-1)-3270. 5p. (NYO-3270-14). Dep. CFSTI.

43625 (DOCKET-50206-85) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, December 1968. (Southern California Edison Co., Los Angeles). Jan 1969. Contract AT(30-1)-3270. 6p. (NYO-3270-21). Dep. CFSTI.

43626 (DOCKET-50206-86) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, January 1969. (Southern California Edison Co., Los Angeles). Feb 1969. Contract AT(30-1)-3270. 6p. (NYO-3270-22). Dep. CFSTI.

43627 (DOCKET-50213-72) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 70-7, July 1970. (Connecticut Yankee Atomic Power Co., Haddam). 24 Aug 1970. Contract AT(30-1)-3250. 13p. (NYO-3250-50). Dep. CFSTI.

43628 (DOCKET-50219-100) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Semiannual Report No. 2, January 1-June 30, 1970. (Jersey Central Power and Light Co., Morristown, N. J.). 14 Jul 1970. 21p. Dep. CFSTI.

43629 NUCLEAR POWER PLANT OBRIGHEIM: EXPERIENCE DURING THE FIRST YEAR OF OPERATION. Schenk, H.; Mayr, A. (Kernkraftwerk Obrigheim GmbH, Ger.). Atomwirt., Atomtech.; 15: 324-9(Jul 1970). (In German).

For the nuclear power plant Obrigheim, operational since March 1969, a one-year survey was conducted. It was functioning approximately 91% of the time. Eight sudden shutdowns occurred that were caused by experimental procedures and failures of electrical equipment; most deficiencies could be repaired within one hour. Eight times the reactor was intentionally shut down chiefly for repair of leaks; nature and location of the defects are presented. Radioactivity in the primary cooling system and experience with reactor core and fuel elements are discussed. In addition, behavior is described for heat exchanger, cooling pumps, and turbine. (H.B.G.)

43630 EXPERIENCE OF THE YANKEE AND CONNECTICUT YANKEE NUCLEAR POWER STATIONS. Minnick, L. E.; Vandenburgh, D. E. (Yankee Atomic Electric Co., Boston). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 82, 40-7(Mar-Apr 1970). (In French).

The experience gained in the operation of Yankee and Connecticut Yankee Nuclear Power Stations is described. Many aspects of the running of a reactor, considered today as normal, were experimented in the Yankee power station. The most significant of these is reviewed. (auth) (France)

43631 OPERATING EXPERIENCE. Khan, M. A.; Ristic, M. (International Atomic Energy Agency, Vienna). Nucl. Eng. Int.; 15: 521-6(Jun 1970).

The performance of light water, heavy water, and gas-cooled graphite moderated, reactors is reviewed. Most of the problems encountered were caused by on-load refuelling machines, saturated steam turbines, leakage in steam generators, difficulties with pressure vessels and tubes, failures due to flow-induced vibrations, control and instrumentation, pumps and circulators, corrosion, and effect of irradiation of materials. Recommendations are for greater effort in the design, development, quality control testing, and in-service inspection of conventional components. The role of the IAEA is described. (UK)

43632 MECHANICAL FAILURES IN THE CHOOZ REACTOR. Aboudarham, L.; Delava, R.; Erkes, P.; Kieffer, J. Energ. Nucl. (Paris); 12: 211-23(May-Jun 1970). (In French).

The nuclear plant at Chooz was put out of action for a period of two years six months after initial startup. This was a consequence of defects occurring within the reactor as a result of various bolting devices breaking under the stresses generated by water flow vibrations. An analysis of these failures is given. The repairs made are described, and a review of the tests made on the site to check the quality of the repairs is given. (auth) (France)

43633 EXPERIENCE ACQUIRED WITH LIGHT WATER MODERATED REACTORS. Stern, Theodore (Westinghouse

Electric Corp., Pittsburgh). Energ. Nucl. (Paris); 12: 125-34 (Mar-Apr 1970). (In French).

Problems arising in the design of light water reactors are discussed. Information collected from the nuclear power stations is presented. The measures taken to remedy the unforeseen incidences which occurred in the first installations are mentioned. The development of light reactors, their economic aspects, and the place reserved for them in future nuclear power stations are discussed in detail. (auth) (France)

43634 USE OF ATOMIC ENERGY IN EAST GERMANY. Faul'shtikh, Kh.; Kherfort, L.; Merts, V.; Maier, K.; Rambush, K.; Shimmel, V.; Shtol'ts, V. At. Energ. (USSR); 28: 338-41(Apr 1970). (In Russian).

The VVR-S reactor was used not only for nuclear studies, but also for the production of radioactive isotopes. This reactor was also used as a materials testing reactor. From 1960 to 1967 the economic benefit from the use of radioisotopes in the national economy was about 500 million marks. The isotopes center had about 1000 customers inside the country and abroad. The atomic energy plant "Rheinsberg" with an electrical power of 70 MW went into operation on May 9, 1966. The experience acquired in designing and building this plant is valuable from a national point of view. The reactor is operating reliably. At present the atomic energy plant "Nord" is being built at Lubmin on the shores of the Baltic Sea to supply the northern part of East Germany with electrical energy. (TTT)

Safety and Siting

43635 (DOCKET-1151-38) ELK RIVER REACTOR. Operating Authorization No. DPRA-3, Amendment 1. (Division of Reactor Licensing (AEC), Washington, D. C.). 6 Aug 1970. 6p. Dep. CFSTI.

43636 (DOCKET-1155-57) LA CROSSE BOILING WATER REACTOR. Affects on Reactor of Loss of Load Transient Conditions. (Dairyland Power Cooperative, La Crosse, Wis.). 27 Jul 1970. 22p. Dep. CFSTI.

43637 (DOCKET-1155-61) LA CROSSE BOILING WATER REACTOR. Analysis of Critical Regions of Main Circulation and Feedwater Piping. Book 1. Summary. (Teledyne Materials Research Co., Waltham, Mass.). 26 Mar 1970. Contract AT(11-1)-850. 11p. (E-1236(a)(Bk.1)). Dep. CFSTI.

For Allis-Chalmers, Atomic Energy Div., Bethesda, Md.

43638 (DOCKET-1155-62) LA CROSSE BOILING WATER REACTOR. Analysis of Critical Regions of Main Circulation and Feedwater Piping. Book 2. Feedwater Nozzle Thermal Sleeve. (Teledyne Materials Research Co., Waltham, Mass.). 26 Mar 1970. Contract AT(11-1)-850. 55p. (E-1236(a)(Bk.2)). Dep. CFSTI.

For Allis-Chalmers, Atomic Energy Div., Bethesda, Md.

43639 (DOCKET-1155-63) LA CROSSE BOILING WATER REACTOR. Analysis of Critical Regions of Main Circulation and Feedwater Piping. Book 3. Feedwater Nozzle: Main Circulating Elbow Intersection. (Teledyne Materials Research Co., Waltham, Mass.). 26 Mar 1970. Contract AT(11-1)-850. 88p. (E-1236(a)(Bk.3)). Dep. CFSTI.

For Allis-Chalmers, Atomic Energy Div., Bethesda, Md.

43640 (DOCKET-1155-64) LA CROSSE BOILING WATER REACTOR PRESSURE VESSEL: INVESTIGATION OF A LAMINAR INDICATION IN THE PLATE. Topical Report No. 9. (Southwest Research Inst., San Antonio, Tex.). 29 Apr 1970. Contract AT(11-1)-1228. 36p. (SwRI-1228-P-11-13). Dep. CFSTI.

43641 (DOCKET-1155-65) LA CROSSE BOILING WATER REACTOR. Incident Report No. DPC-70-10. (Dairyland Power Cooperative, La Crosse, Wis.). 26 Jul 1970. 3p. Dep. CFSTI.

An operations incident of July 26, 1970 is described which involved the scram of all rods. The scram was due to a spurious signal from the pressure channel No. 1. A second scram was actuated by the pressure channel No. 2 while a check was being performed on channel No. 1. The second scram was a result of the checking procedures for channel No. 1. Corrective actions are described. (D.C.C.)

43642 (DOCKET-1155-66) LA CROSSE BOILING WATER REACTOR. Incident Report No. DPC-70-11. (Dairyland Power Cooperative, La Crosse, Wis.). 11 Aug 1970. 2p. Dep. CFSTI.

An operations incident of August 3, 1970 is described which involved a reactor scram. The scram was due to a failure in a seal injection system check valve. Corrective actions are described. (D.C.C.)

43643 (DOCKET-1155-67) LA CROSSE BOILING WATER REACTOR. Incident Report No. DPC-70-12. (Dairyland Power Cooperative, La Crosse, Wis.). 10 Aug 1970. 3p. Dep. CFSTI.

An operations incident of August 5, 1970 is described which involved the scram of all rods. The scram was due to a spurious signal from the pressure channel No. 1. Corrective actions are described. (D.C.C.)

43644 (DOCKET-50003-47) INDIAN POINT STATION, UNIT NO. 1. Technical Specifications, Temporary Amendment to Provide Access. (Consolidated Edison Co. of New York, Inc., New York). 7 Aug 1970. 2p. Dep. CFSTI.

The use of a seven foot door in the containment structure for maintenance access to the reactor is requested. Maintenance operations requirements are described. (D.C.C)

43645 (DOCKET-50146-58) SAXTON REACTOR. Technical Specifications Change Request No. 37. (Saxton Nuclear Experimental Corp., Pa.). 18 Aug 1970. 4p. Dep. CFSTI.

Technical specifications providing for fuel subassemblies that contain test fuel rods and that may or may not have center-located flux thimbles are presented. (D.C.C.)

43646 (DOCKET-50146-59) SAXTON REACTOR. License No. DPR-4. Technical Specifications Change No. 37. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Aug 1970. 2p. Dep. CFSTI.

Technical specifications are revised concerning the operation of fuel subassemblies near the core periphery without a flux thimble in the center rod position. (D.C.C.)

43647 (DOCKET-50155-46) BIG ROCK POINT NUCLEAR PLANT. Containment Leak Rate Test. Special Report No. SR-11. (Consumers Power Co., Jackson, Mich.). 10 Aug 1970. 17p. Dep. CFSTI.

43648 (DOCKET-50206-87) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Application of Permanent Operating License. Preliminary Safety Analysis Report, Amendment 19. (Southern California Edison Co., Los Angeles). 28 Jul 1970. 83p. Dep. CFSTI.

43649 (DOCKET-50213-71) CONNECTICUT YANKEE ATOMIC POWER PLANT. Repair and Inspection of Steam Generator Primary Nozzle Safe-Ends, May-June 1970. Final Report. (Westinghouse Electric Corp., Tampa, Fla.). 15 Jul 1970. 11p. Dep. CFSTI.

For Connecticut Yankee Atomic Power Co., Westboro, Mass.

43650 (DOCKET-50219-99) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Nondestructive Testing Report for Selected Balance of Plant Systems Outside of Primary Containment. (Jersey Central Power and Light Co., Morristown, N. J.). Jul 1970. 19p. Dep. CFSTI.

43651 (DOCKET-50220-48) NINE MILE POINT NUCLEAR STATION. Request for Additional Information Pertaining to Application for Power Increase. (Division of Reactor Licensing (AEC), Washington, D. C.). 27 Aug 1970. 4p. Dep. CFSTI.

43652 (DOCKET-50237-66) DRESDEN NUCLEAR POWER STATION, UNIT 2. Proposed Change No. 4 to Appendix A of DPR-19, Supplement No. 2. (Commonwealth Edison Co., Chicago, Ill.). 11 Aug 1970. 3p. Dep. CFSTI.

Information related to modified venting procedures for the containment structure is presented. (D.C.C.)

43653 (DOCKET-50245-38) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Description of Work Being Done to Comply with ACRS Recommendations. (Connecticut Light and Power Co., Hartford, Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield, Millstone Point Co., Wethersfield, Conn.). 24 Aug 1970. 20p. Dep. CFSTI.

43654 (DOCKET-50247-39) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Applicant's Environmental Report: Operating License Stage. (Consolidated Edison Co. of New York, Inc., New York). 6 Aug 1970. 58p. Dep. CFSTI.

Information concerning chemical, radioactive, thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

43655 (DOCKET-50247-40) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Preliminary Safety Analysis Report,

Amendment 23 (Includes Final Facility Description and Safety Analysis Report, Suppl. 13). (Consolidated Edison Co. of New York, Inc., New York). 13 Aug 1970. 221p. Dep. CFSTI.

43656 (DOCKET-50249-39) DRESDEN NUCLEAR POWER STATION, UNIT 3. Hydrogen Generation in a Boiling Water Reactor. Preliminary Safety Analysis Report, Amendment 23. (Commonwealth Edison Co., Chicago, Ill.). 11 Aug 1970. 52p. Dep. CFSTI.

43657 (DOCKET-50250-28) TURKEY POINT PLANT, UNITS NO. 3 AND NO. 4. Preliminary Safety Analysis Report, [Amendment 22], Suppl. 22. (Florida Power and Light Co.). 12 Aug 1970. 209p. (DOCKET-50251-26). Dep. CFSTI.

43658 (DOCKET-50250-29) TURKEY POINT PLANT, UNITS NO. 3 AND NO. 4. Preliminary Safety Analysis Report, [Amendment 23], Suppl. 23. Foundation Investigation Report. (Florida Power and Light Co.). 25 Aug 1970. 71p. (DOCKET-50251-27). Dep. CFSTI.

Geologic data for the reactor site are presented. Results of exploration borings are included. (D.C.C.)

43659 (DOCKET-50255-28) PALISADES PLANT. Provisional Construction Permit No. CPPR-25: Extension of Completion Date. (Division of Reactor Licensing (AEC), Washington, D. C.). 28 Aug 1970. 3p. Dep. CFSTI.

43660 (DOCKET-50259-12) BROWNS FERRY NUCLEAR PLANT, UNITS 1 AND 2. Based on Precedent of Unit 3, Baffles will be Removed From Suppression Chambers of Units 1 and 2. (Tennessee Valley Authority, Chattanooga. Office of Power). 1p. (DOCKET-50260-12). Dep. CFSTI.

43661 (DOCKET-50261-41) H. B. ROBINSON UNIT NO. 2. Basis for Revision in Safety Injection Pump Performance. Technical Specifications. (Carolina Power and Light Co., Raleigh, N. C.). 12 Aug 1970. 14p. Dep. CFSTI.

43662 (DOCKET-50261-42) H. B. ROBINSON UNIT NO. 2. Additional Information Concerning Seismic Analysis of Class I Piping and Equipment, Addendum A. (Carolina Power and Light Co., Raleigh, N. C.). 18 Aug 1970. 3p. Dep. CFSTI.

43663 (DOCKET-50266-27) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Environmental Considerations. (Division of Reactor Licensing (AEC), Washington, D. C.). 7 Aug 1970. 16p. (DOCKET-50301-23). Dep. CFSTI.

43664 (DOCKET-50269-21) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Preliminary Safety Analysis Report, Amendment 17 (Includes Final Safety Analysis Report, Rev. 9). (Duke Power Co., Charlotte, N. C.). 11 Aug 1970. 194p. (DOCKET-50270-21; DOCKET-50287-18). Dep. CFSTI.

43665 (DOCKET-50271-26) VERMONT YANKEE NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 14, Supplement. (Vermont Yankee Nuclear Power Corp., Rutland). 11 Aug 1970. 14p. Dep. CFSTI.

Financial statements related to the owners of Vermont Yankee Power Reactor are presented. (D.C.C.)

43666 (DOCKET-50280-26) SURRY POWER STATION, UNITS 1 AND 2. NORTH ANNA POWER STATION, UNITS 1 AND 2. Deficiencies of Pressure Vessel Fabrication Procedures. (Division of Compliance (AEC), Washington, D. C.). 14 Aug 1970. 3p. (DOCKET-50281-26; DOCKET-50338-22; DOCKET-50339-21). Dep. CFSTI.

43667 (DOCKET-50282-21) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Deficiencies of Pressure Vessel Fabrication Procedures. (Division of Compliance (AEC), Washington, D. C.). 13 Aug 1970. 3p. (DOCKET-50306-21). Dep. CFSTI.

43668 (DOCKET-50285-26) FORT CALHOUN STATION, UNIT NO. 1. Preliminary Safety Analysis Report, Amendment 19 (Includes Final Safety Analysis Report, Suppl. No. 2). (Omaha Public Power District, Nebr.). 13 Aug 1970. 215p. Dep. CFSTI.

Safety limits and inspection requirements for reactor systems are described. Personnel qualifications and responsibilities are listed. (D.C.C.)

43669 (DOCKET-50285-27) FORT CALHOUN STATION, UNIT NO. 1. Misplaced Reinforcing Steel Containment Wall Pours CW-4 and CW-5. (Omaha Public Power District, Nebr.). 20 Aug 1970. 2p. Dep. CFSTI.

43670 (DOCKET-50305-8) KEWAUNEE NUCLEAR POWER PLANT. Compliance with Applicable Water Quality Standards. (Wisconsin Public Service Corp., Green Bay). 5 Aug 1970. 3p. Dep. CFSTI.

43671 (DOCKET-50329-19) MIDLAND PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 15. (Consumers Power Co., Jackson, Mich.). 14 Aug 1970. 4p. (DOCKET-50330-18). Dep. CFSTI.

Radioactivity limits for tertiary system steam are presented. (D.C.C.)

43672 (DOCKET-50336-18) MILLSTONE NUCLEAR POWER STATION, UNIT NO. 2. Safety Evaluation. (Division or Reactor Licensing (AEC), Washington, D. C.). 7 Aug 1970. 96p. Dep. CFSTI.

43673 (DOCKET-50338-21) NORTH ANNA POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 11. (Virginia Electric and Power Co., Richmond). 12 Aug 1970. 50p. (DOCKET-50339-20). Dep. CFSTI.

Financial data on the owners of the North Anna Power Reactor Units 1 and 2 are given in support of the application for construction permit and operating license. The 1969 Annual Report for the Virginia Electric and Power Company is included. (D.C.C.)

43674 (DOCKET-50346-12) DAVIS-BESSE NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 8. (Toledo Edison Co., Ohio). 7 Aug 1970. 239p. Dep. CFSTI.

43675 (DOCKET-50346-13) DAVIS-BESSE NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 9. (Toledo Edison Co., Ohio). 13 Aug 1970. 4p. Dep. CFSTI.

Design specifications to protect Class 1 piping systems from whip damage are revised. (D.C.C.)

43676 (DOCKET-50346-14) DAVIS-BESSE NUCLEAR POWER STATION. Applicants' Environmental Report; Construction Permit Stage. (Toledo Edison Co., Ohio). 3 Aug 1970. 113p. Dep. CFSTI.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

43677 (DOCKET-50346-15) DAVIS-BESSE NUCLEAR POWER STATION. ACRS Report. (Atomic Energy Commission, Washington, D. C. Advisory Committee on Reactor Safeguards). 27 Aug 1970. 5p. Dep. CFSTI.

43678 (DOCKET-50346-16) DAVIS-BESSE NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 10. (Toledo Edison Co., Ohio). 27 Aug 1970. 57p. Dep. CFSTI.

Financial data on the owners of the Davis-Besse Power Reactor are presented in support of the application for construction permit and operating license. The 1969 Annual Reports for the Toledo Edison Company and the Cleveland Electric Illuminating Company are included. (D.C.C.)

43679 (DOCKET-50348-8) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 3. (Alabama Power Co., Birmingham). 17 Aug 1970. 158p. (DOCKET-50348-8). Dep. CFSTI.

43680 (DOCKET-50366-1) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Receipt of Application for Construction Permit and Operating License. (Division of Reactor Licensing (AEC), Washington, D. C.). 26 Aug 1970. 3p. Dep. CFSTI.

43681 (ORNL-NSIC-28) EARTHQUAKES AND NUCLEAR POWER PLANT DESIGN. Lomenick, T. F.; (and others) (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 216p. Dep. CFSTI.

A survey was made of the state of technology in the design of nuclear power plants to withstand earthquakes to the extent necessary for safety in order to present technical management with information needed in making decisions on safety research. The principal active contributors to the fields of research on earthquakes are identified. Present activities in the engineering field and related earth sciences reveal substantial evolution of engineering practice for earthquake survival, which has been stimulated by the occasional occurrence of large earthquakes. It was found that engineering for nuclear facilities developed from the preexisting building codes and engineering practices to a point at which the consideration of public safety generally dictates more conservatism in design. In this survey the bases for siting and design of nuclear power plants in the United States were studied

in consultation with both industry and regulatory personnel. It was found that in all geographical areas nuclear plants are currently designed to withstand safely more severe earthquakes than are considered in the design of other modern structures in the same locations. A substantial body of knowledge on earthquakes has been accumulated and is being utilized in the siting and design of nuclear facilities. While the probabilities of occurrence of earthquakes of various intensities are not known well in the sense that the incidence of other severe natural phenomena is known, it is generally recognized that all nuclear plants can be expected to be shaken by an earthquake of some intensity. Further, there is little doubt that nuclear plants can be designed to withstand the most severe earthquake vibration with a good margin for safety. A review of engineering practices shows that the site-sensitive factors that determine the transmission of vibrational energy to plant structures or which contribute to secondary effects, such as slides and tsunamis, are generally recognized as important; but methods for making better quantitative assessment of these factors in siting surveys need to be developed. Where the propensity for adverse secondary effects is recognized the problem can usually be resolved with current and common design practice, although the methods commonly used will be refined and improved by future development of survey techniques. Surface faulting is a common occurrence in many earthquakes in the western United States and has posed difficulties in siting nuclear power plants in that region. Research in both the earth science and engineering aspects of faulting is recommended, although the current practice is to avoid location of a reactor on an active fault. Precise prediction of future earthquakes in time and place is not likely to be possible in the near future. This situation is not a serious disadvantage in nuclear plant safety provided the safety consequences of all possible effects on the system are considered early in the design. This provision is the subject of recommendations on engineering and design studies. (auth)

43682 (ORNL-NSIC-69) SAFETY-RELATED OCCURRENCES IN NUCLEAR FACILITIES AS REPORTED IN 1967 AND 1968. Cramer, E. N.; Casto, W. R. (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 116p. Dep. CFSTI.

Four hundred and sixty-three occurrences that were reported in 1967 and 1968 in material entering the AEC Public Document Room, Washington, D. C., or the Nuclear Safety Information Center, Oak Ridge, Tennessee, are abstracted. Occurrences were selected with the subjective judgment that a given happening may indicate the need for better administrative control or hardware. For convenience, the information was organized into the following sections: Reactor Occurrences: BWR, PWR, Non-Water Power Reactors, Research and Test Reactors; Radiography Occurrences; Other Facilities Occurrences; Miscellaneous Occurrences. (auth)

43683 SITING OF BROWN'S FERRY NUCLEAR PLANT. Gilleland, J. E. J. Power Div., Amer. Soc. Civil Eng.; 95: 185-91(Oct 1969).

Factors in considering siting a nuclear plant include where the power is needed, transmission connections, access, cooling water, meteorology, geology, seismology, population distribution, exclusion area, and effects on air and water quality. The TVA Browns Ferry Plant has met all site considerations. (Fuel Abstr.)

43684 EMERGENCY PLANS AT NUCLEAR POWER STATIONS. Bonnell, J. A. (Central Electricity Generating Board, Berkeley, Eng.). Trans. Soc. Occup. Med.; 20: 20-2(Jan 1970).

Some of the plans for action to inform and protect the general public following reactor accidents resulting in fission product release are presented. The situation of a transport accident involving a shipment of irradiated fuel elements is also discussed. (H.D.R.)

Power Reactor Development

Refer also to abstracts 41565, 41566, 41570–41574, 41581, 41582, 41601, 41603, 41628, 41630, 41709, 42053, 42064, 42095, 42177, 42188–42196, 42198, 42202, 42205, 42228, 42230, 42232, 42255, 42277, 42279, 42281, 42283, and 42286.

43685 (AAEC/TM-534) NEUTRONICS AND ASSOCIATED ASPECTS IN THE DESIGN OF SMALL BERYLLIUM OXIDE MODERATED H,T,G,C. REACTORS. Manning, G. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar 1970. 42p. Dep. CFSTI (U. S. Sales Only).

The results of detailed neutronic design calculations are presented and discussed for a specific ordered array design of a small pebble bed beryllium oxide moderated air cooled reactor which represents a simple and feasible power reactor demonstration concept. Some survey calculations relating to slightly larger-sized continuously refueled pebble bed reactors are also provided. The concepts are compared and means of significantly improving performance are suggested. The work described forms part of the ABORIGINE (Air cooled-Beryllium-Oxide-Reactor-with-Integral-Gas-turbINE) Project. (auth) (Australia)

43686 (ANL-7705) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, JUNE 1970. (Argonne National Lab., Ill.). 31 Jul 1970. Contract W-31-109-eng-38. 196p. Dep. CFSTI.

Highlights of project activities for June 1970 are summarized. LMFBR physics development and component development are reviewed. Operations and analysis of ZPR-3, ZPR-6, ZPR-9, and ZPPR are described. The EBR-2 research and development projects, fuel fabrication, and operations are summarized. Reactor fuels and materials development, physics studies, engineering development, fuel cycle chemistry, and LMFBR safety studies are reported. (D.C.C.)

43687 (APDA-261) QUARTERLY TECHNICAL PROGRESS REPORT ON AEC-SPONSORED ACTIVITIES, JANUARY-MARCH 1970. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 47p. Dep. CFSTI.

CHROMIUM ALLOYS AND SYSTEMS — Cr-Mo-steel, corrosion by liquid sodium, effects of water injection rate on, (E)
LIQUID METAL FAST BREEDER REACTOR — coolant for, corrosive properties of liquid sodium, (E)
— physics parameters for, comparison of methods for heterogeneity effects on, (T)
MOLYBDENUM ALLOYS AND SYSTEMS — Cr-Mo-steel, corrosion by liquid sodium, effects of water injection rate on, (E)
SODIUM — corrosive effects on chromium-molybdenum alloy steel tubes, effects of water injection rate on
STEEL — Cr-Mo-steel, corrosion by liquid sodium, effects of water injection rate on, (E)

43688 (BNWL-tr-51) THE EXPERIMENTAL FAST REACTOR BOR. Borisiouk, E. V.; Griazev, V. M.; (and others). Translated by E. R. Appleby (Battelle-Northwest, Richland, Wash.), from Energ. Nucl. (Paris); 12: 33-8(Jan 1970). 18p. Dep. CFSTI.

The 60 MW(t) experimental fast reactor BOR at Melekess and its associated research facilities are described. Overall design parameters are tabulated, and the core, shielding, reactor vessel, loading system, coolant loops, heat exchangers, and irradiation facilities are discussed. (H.D.R.)

43689 (CONF-700307-5) THE DEVELOPMENT IN FRANCE OF COMPONENTS OF SODIUM CIRCUITS FOR SODIUM-COOLED FAST REACTORS, AND FUTURE PERSPECTIVES. Pontier, R.; Benoist, E.; Delisle, J. P.; Marmonier, P. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires); Crette, J. P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); de Montardy, A. (Electricite de France les Renardieres); Peyrot, J. P. (Soceiete CLOVER, Villejuif (France)). [nd]. 26p. (SM-130/30). Dep. CFSTI.

From Symposium on Progress in Sodium-Cooled Fast Reactor Engineering, Monaco.

The implementation of the RAPSODIE and PHENIX projects has gone hand in hand with the development of components which were adapted first to an experimental reactor and subsequently to a prototype reactor. The RAPSODIE components have proved themselves by enabling the reactor to operate with a sizable load factor. Those for the PHENIX are either being tested now or will be tested next year. New studies have been undertaken with a view to improving the PHENIX components, to adapting them for a large reactor and to lowering their cost. Details are presented of what is being done along these lines as far as the main components of sodium circuits are concerned. (auth)

43690 (DP-Report-87) O.E.C.D. HIGH TEMPERATURE REACTOR PROJECT DRAGON. Project DRAGON. Marien, P. (Atomic Energy Establishment, Winfrith (England)). Mar 1962. 38p. (In French). Dep. CFSTI.

The research and development goals of the Dragon Project for high temperature gas cooled reactors are reviewed. Design parameters of the 20 MW(t) reactor experiment are tabulated and discussed. Various aspects of the research program, including fuel and graphite development, irradiation testing, and helium purification, are described. (H.D.R.)

43691 (DP-Report-355) NINTH SEMI-ANNUAL REPORT, JULY 1, 1964–DECEMBER 31, 1964. Project DRAGON. Kaul, Peter (ed.) (Atomic Energy Establishment, Winfrith (England)). Jun 1965. 193p. Dep. CFSTI.

The work of the Dragon Project for the period 1st July, 1964 to 31st December, 1964 is reported under the following headings: reactor physics; carbon transport; coolant processing; the fuel element; engineering and technical studies; reactor operation; and assessment studies. (auth)

43692 (DP-Report-368) REPORT ON WORK AT A.E.R.E. FOR THE DRAGON PROJECT, OCTOBER 1964–APRIL 1965. Project DRAGON. (Atomic Energy Research Establishment, Harwell (England)). Jul 1965. 17p. (AERE-PR/D-8). Dep. CFSTI.

Post-irradiation measurements on pyrolytic carbon coated ThC_2–UC_2 fuel particles from the PLUTO loop and the HPD rigs are presented. Fission product movement in particle fuels and special graphites is analyzed. Properties of graphite are studied. (13 references) (auth)

43693 (DP-Report-382) GRAPHITE IRRADIATIONS IN THE SECOND UP-RATED ELEMENT, FIRST CHARGE POSITION 3/5. Project DRAGON. Voice, Eric (Atomic Energy Establishment, Winfrith (England)). Dec 1965. 52p. Dep. CFSTI.

Included in the Dragon core are large numbers of graphite specimens to assess their possibilities for a future power reactor. Several fuel elements containing such specimens will be withdrawn after different intervals, providing various neutron doses and degrees of damage. The specimens in the second element are described, giving details of the nature of the graphites, the sample positions, the temperatures and fluxes anticipated, the pre-irradiation data, the methods of flux monitoring and the post-irradiation measurements required. 18 references. (auth)

43694 (DP-Report-390) TENTH SEMI-ANNUAL REPORT FOR THE PERIOD JANUARY 1, 1965–JUNE 30, 1965. Project DRAGON. Ashworth, F. P. O. (ed.) (Atomic Energy Establishment, Winfrith (England)). Dec 1965. 183p. Dep. CFSTI.

Progress during the period is reported under the following headings: reactor physics; carbon transport and coolant chemistry; the fuel elements; engineering and technical studies; reactor operation; and assessment studies. (auth)

43695 (DP-Report-397) REPORT ON WORK AT A.E.R.E. FOR THE DRAGON PROJECT, APRIL–OCTOBER 1965. Project DRAGON. (Atomic Energy Research Establishment, Harwell (England)). Dec 1965. 9p. (AERE-PR/D9). Dep. CFSTI.

Post-irradiation measurements on pyrolytic carbon coated ThC_2–UC_2 fuel particles from the PLUTO loop and the HPD rigs are presented. Fission product movement in particle fuels and special graphites is analyzed. Properties of graphite are studied. (auth)

43696 (EUR-4488) "ORGEL PROTOTYPE" CONTEST. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1970. 250p. (In French). Dep. CFSTI (U. S. Sales Only). EUR FF 35,55.

Conceptual design parameters for the heavy water-moderated organic-cooled ORGEL Reactor are presented. (D.C.C.)

43697 (GA-10088) HTGR BASE PROGRAM QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING MAY 31, 1970. (Gulf General Atomic, Inc., San Diego, Calif.). 30 Jun 1970. Contract AT(04-3)-167. 95p. Dep. CFSTI.

GRAPHITE—diffusion of strontium in, (E)
—radiation effects on creep and dimensional stability of, neutron
HIGH TEMPERATURE LATTICE TEST REACTOR—physics parameters of HTGR lattices in, (E)
NEUTRONS—effects on graphite creep and dimensional stability
REACTOR FUEL ELEMENTS—reprocessing cycle development for gas cooled
—design of HTGR type, for irradiation testing
REACTOR FUELS—radiation testing of coated particle
REACTORS, GAS COOLED—development of 1000 MW(e) HTGR concept during March through May 1970
—fission product release and transport in high temperature, (E/T)
—fuel elements for high temperature, fabrication and irradiation testing of recycle, (E)
—fuel elements for high temperature, plant designs and costs for reprocessing
REACTORS, POWER—development of 1000 MW(e) HTGR concept during March through May 1970
STRONTIUM—diffusion in graphite, (E)
THORIUM OXIDES ThO_2—ThO_2–UO_2, reprocessing of coated particle fuels of, fluid bed oxidation and leaching procedures in, (E)
URANIUM OXIDES UO_2—ThO_2–UO_2, reprocessing of coated particle fuels of, fluid bed oxidation and leaching procedures in, (E) (H.D.R.)

43698 (IAEA/NPR-9) INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL WORKING GROUP ON FAST REACTORS MEETING OF SPECIALISTS ON SODIUM-WATER REACTIONS, ARGONNE, USA, 5–6 NOVEMBER 1968. (Argonne National Lab., Ill.). 99p. Dep. CFSTI.

The meeting of specialists on sodium-water reactions was attended by representatives of France, Germany, Japan, the United Kingdom, and the United States. The representatives are listed, the agenda is presented, statements made by some of the participants at a panel discussion on the subject are included, and summaries of all contributions to the discussion by the specialists are presented. 38 references. (H.D.R.)

43699 (NP-10431) EARLY WORK ON THERMOCOUPLES TO MEASURE GRAPHITE TEMPERATURE OF 800°C AND HIGHER. Project DRAGON. Reichardt, F. A. (Atomic Energy Establishment, Winfrith (England)). Jun 1961. 17p. (DP-Report-25). Dep. CFSTI.

A chromel/alumel thermocouple sheathed with a Ti stabilized 18/8 austenitic stainless steel has been selected to measure graphite temperatures up to 1100°C in the 7-element rig. The basis of selection, test results, and final calibration are described. Some miscellaneous work on high temperature thermocouples is also included. (auth)

43700 (NP-10467) A DIRECT HEATED GRAPHITE CORROSION LOOP. Project DRAGON. Smyth, R. T.; Sturge, D. W.; Valette, L. (Atomic Energy Establishment, Winfrith (England)). Jun 1961. 17p. (DP-Report-37). Dep. CFSTI.

The operation of a graphite corrosion loop and the results obtained in assessing its usefulness as a graphite corrosion test loop are presented. (auth)

43701 (ORNL-4528) TWO-FLUID MOLTEN-SALT BREEDER REACTOR DESIGN STUDY (STATUS AS OF JANUARY 1, 1968). Robertson, R. C.; Briggs, R. B.; Smith, O. L.; Bettis, E. S. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 80p. Dep. CFSTI.

A conceptual design study of a 1000-MW(e) thermal breeder power station based on a two-fluid MSBR commenced in 1966 as part of a program to determine whether a molten-salt reactor using the thorium-^{233}U fuel cycle could produce electric power at sufficiently low cost to be of interest and at the same time show good utilization of U.S. nuclear fuel resources. The progress made in the study up to August 1967, at which time the two-fluid MSBR work was set aside in order to study a single-fluid MSBR concept, is reported. The two-fluid MSBR is graphite-moderated and -reflected, with a ^7LiF–BeF_2–UF_4 fuel salt circulated through the core and a ^7LiF–ThF_4–BeF_2 blanket salt circulated through separate flow channels distributed throughout the core, as well as in a surrounding undermoderated region. The fissions raise the temperature of the fuel salt to about 1300°F and that of the blanket salt to about 1250°F. Heat is removed from the salts in shell-and-tube heat exchangers to raise the temperature of a circulating $NaBF_4$–NaF coolant salt to about 1150°F. The coolant salt transports the heat to steam generators and reheaters to provide 3500-psia 1000°F/1000°F steam for a conventional turbine-generator. The conceptual design was based on use of four reactors and the associated heat transfer systems in a so-called modular arrangement to supply steam to a single turbine-generator. This made it practical to consider replacement of an entire reactor vessel assembly after the core graphite received its allowable exposure to neutrons. The total fluence at which it was thought that additional graphite dimensional changes would become excessive was taken as 3×10^{22} neutrons/cm^2 ($E > 50$ keV), or about eight years of full-power operation. All portions of the systems in contact with the fluoride or fluoroborate salts would be fabricated of Hastelloy N that has a small amount of titanium added to improve the resistance to radiation damage. The graphite would be a specially coated grade having low gas permeability to xenon and better resistance to radiation damage than conventional material. The two-fluid concept involves joining graphite core elements to Hastelloy N tubing using a brazing process developed at ORNL. The reactors and associated systems would be housed in concrete cells to provide biological shielding and double containment of all radioactive materials. Plant flowsheets and layouts were developed sufficiently during the study to give an indication of feasibility and to give a basis for cost estimates, but no optimization studies were made. Safety aspects were considered throughout the design effort, but no formal safety analysis was completed. Fuel and blanket salts would be continuously processed in a nearby cell to remove fission products and

to recover the bred product. The processing rate would correspond to removal of uranium and protactinium from the blanket on a 3-day cycle and rare-earth fission products from the core on a 60-day cycle. Since no conceptual designs for the chemical plant were completed, cost estimates could not be on a definitive basis. The tentatively estimated fuel cycle cost is about 0.5 mill/kWhr, which includes the fixed charges and operating costs for the processing equipment, the fuel inventory charge, and the credit for bred fuel. Graphite replacement costs, which are not included, would add about 0.2 mill/kWhr. The tentatively estimated total construction cost of a 1000-MW(e) MSBR station, based on the early 1968 value of the dollar, is about $141 per kilowatt. The power production cost for a privately owned station, based on fixed charges of 13.7% and 80% plant factor, is about 4 mills/kWhr. The net thermal efficiency of the plant would be about 44.9%. The study did not disclose any aspects which indicated that major technological discoveries would be required to design a two-fluid molten-salt reactor power station. The major concern was whether mechanical failure of graphite tubes in the reactor core would cause the effective lifetime of the core to be significantly less than the eight years imposed by the effects of irradiation on the graphite. (auth)

43702 (UNC-SPLM-1059) MINUTES, SPECIALISTS MEETING ON SODIUM–WATER REACTIONS HELD UNDER THE AUSPICES OF THE INTERNATIONAL ATOMIC ENERGY AGENCY AT ARGONNE NATIONAL LABORAROY, NOVEMBER 5–6, 1968. Goldmann, Kurt (Argonne National Lab., Ill.). 15 Oct 1969. 56p. Dep. CFSTI.

The minutes for the specialists meeting for the United States team, a list of participants, a reference list, and the panel discussions containing summary reports on the specialists' meeting are presented. 34 references. (H.D.R.)

43703 NOT LMFBR OR GCFR BUT FBR. Rennie, C. A. Nucl. Eng. Int.; 15: 629-31(Jul-Aug 1970).

The background to fast reactor development and the present status of fast reactors are briefly summarized. Comparisons are made between helium and sodium as coolants. The need for internal cooperation particularly in the field of gas-cooled fast reactors is discussed. (UK)

43704 POWER REACTOR ACTIVITIES AT THE INSTITUTT FOR ATOMENERGI. Ager-Hansen, Henrik (Institutt for Atomenergi, Kjeller, Norway). Tek. Ukebl.; 116: 418-22(10 Apr 1969). (In Norwegian).

Project studies, carried out in cooperation with Norway's Hydroelectric Authority and a large electro-chemical concern have concentrated on the boiling light water and advanced gas cooled reactor types. Alternative sites have been evaluated with underground containment on one and conventional containment on the other. The use of prestressed concrete pressure vessels and of concrete vessels directly cast in rock has been investigated. A computer based fuel strategy giving a 2-region, 4 and 5 system has been developed. A study of reactor components in cooperation with Norwegian industry indicates that a significant proportion of the nuclear part of the plant can be produced by local industry. The Institute's effort in the field of fast reactor technology is dependent on Nordic cooperation. (Norway)

43705 SURVEY OF ACTIVITIES AT THE INSTITUTT FOR ATOMENERGI. Eriksen, V. O. (Institutt for Atomenergi, Kjeller, Norway). Tek. Ukebl.; 116: 412-16(10 Apr 1969). (In Norwegian).

The main fields of effort are defined and treated. In power reactor technology the Institute follows parallel national Nordic courses. Fuel technology is based largely on the Halden Reactor Project, for which fuel, cladding, and in-core instrumentation are produced. Work on process regulating is also concentrated on the Halden Project, where digital computer techniques are being developed. Reactor safety studies with special reference to future power plants are carried out for the appropriate national Authorities. Production of radioisotopes and their use in medicine and industry are important functions. Early experience in uranium reprocessing techniques is now applied in the separation of rare earths and other rare metals. The research reactor JEEP II is used for fundamental research in solid state physics, structural and nuclear chemistry. (Norway)

43706 FEATURES OF ATOMIC ENERGY REACTORS IN POWER ENGINEERING. Anan'ev, E. P.; Kruzhilin, G. N. At. Energ. (USSR); 28: 291-4(Apr 1970). (In Russian).

The USSR has two, fast neutron power reactors cooled by liquid Na: the first with a power of 350 MW(e) is being built at Shevchenko, and the second with a power of 600 MW is at the Beloyarskii Power Plant. It is pointed out that the cost of electricity for the water-water reactor at the Novo-Voronezhskii Power Plant with a 210 MW(e) is 0.95 cents/kWh, and will drop to 0.4 cents/kWh at a power of 1000 MW. The cost of electricity will be even lower for fast neutron reactors. At these costs it becomes possible to use electrical energy in many industrial processes. Coal-burning electrical plants present problems in environmental pollution and in fuel transport costs. Thus the shortage of electrical energy in the European part of the USSR can be more conveniently met by the use of atomic energy plants than by coal-burning plants because of coal transport costs. Atomic energy plants seem better suited for carrying the base load rather than for meeting peak requirements. However, in a number of atomic reactors operating on steam it is possible to vary the power somewhat. Since fast neutron reactors operate to convert inert ^{238}U to fissionable ^{239}Pu, they should be used to meet base requirements. (TTT)

43707 PRESENT AND FUTURE FOR THE DEVELOPMENT OF FAST REACTORS. Leipunskii, A. I. At. Energ. (USSR); 28: 297-302(Apr 1970). (In Russian).

The decision to develop fast neutron reactors was based on finding a low α value (ratio of capture cross-section to fission cross section) for ^{239}Pu, the development of Na metal as a suitable coolant, and extensive measurements of fission cross-sections of ^{238}U, ^{233}U, ^{239}Pu, ^{240}Pu, ^{241}Pu and ^{232}Th on the BR-5 reactor which has been already operating for 11 years on an oxide fuel. Experiments on the BR-5 reactor showed that various types of steel had good corrosion stability if the Na metal was kept free of the oxide by the use of cold traps. Carbon which is absorbed by austenitic steel and leads to its embrittlement is also a harmful impurity. A steel cladding operating at 700°C was developed to hold in fission gases at high integral neutron fluxes of 1 to 3×10^{23} neutrons/cm^2. Two large fast neutron reactors include the BN-350 at Shevchenko with a power of 1000 MW(t) and the BN-600 at the Beloyarskii Power Plant with a power of 1500 MW(t). These reactors have a Na exit temperature of 500 to 550°C, a fuel element surface temperature of 680 to 700°C, a maximum neutron flux of 8×10^{15} to 1×10^{16} neutrons/cm^2 · sec, and UO_2 as the fuel clad in steel. The doubling time with an external fuel cycle of 0.5 years can be decreased from 9.4 years for an oxide fuel to 6.5 years by substituting carbide for oxide in the fuel. An analysis of the integral requirements for U over a period of 30 years shows that a delay of 5 years in introducing fast neutron reactors will require an excess of 100,000 tons of natural U. Hence, it is concluded that fast neutron reactors are essential in the complete and full development of cheap, nuclear power. (TTT)

Kinetics and Dynamics

Refer also to abstracts 41676 and 43841.

43708 (AECL-3601) MEASUREMENT TECHNIQUES USING A PSEUDO RANDOM BINARY SEQUENCE AND FOURIER TRANSFORMATION FOR DETERMINING A SYSTEM'S TRANSFER FUNCTION. Lawrence, C. B.; Pearson, A. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr 1970. 47p. Dep. CFSTI (U. S. Sales Only). AECL $1.50.

A method for measuring the transfer function of systems associated with power reactors is described. The method lends itself to doing the measurements on-line with as little disturbance as possible to an operating system. The techniques for obtaining a good signal to noise ratio when noise is unavoidable are presented. The care that must be taken with filtering and timing to ensure good results is discussed. 8 references. (auth)

43709 (DP-Report-249) PROCEEDINGS OF DRAGON PROJECT PHYSICS SYMPOSIUM HELD AT DURLEY HALL HOTEL, BOURNEMOUTH ON 7th, 8th, AND 9th MAY 1963. Project DRAGON. (Atomic Energy Establishment, Winfrith (England)). Dec 1963. 41p. Dep. CFSTI.

Brief reviews of papers related to DRAGON Project physics are presented. Fuel cycle characteristics for a continuously fueled breeder reactor are analyzed. (D.C.C.)

43710 (DP-Report-359) MEASUREMENTS OF CONTROL ROD WORTH AND EXCESS REACTIVITY ON THE FIRST CORE OF DRAGON. Project DRAGON. Cameron, I. R.; Della Loggia, V. E.; Hammond, A. D.; Stillwell, J. C. (Atomic Energy Establishment, Winfrith (England)). Jul 1965. 50p. Dep. CFSTI.

The experimental techniques used for deriving the excess reactivity during the loading of the first Dragon core are described and the method of analysis discussed in detail. The excess reactivity was measured using two virtually independent methods—the two-rod and nitrogen coefficient techniques. The results from the two methods agree well with one another throughout the loading process, despite the necessity for some complicated corrections to the experimental data for effects such as the change in worth of inserted control with core loading. The excess reactivity of the full core is measured as 26.3 ± 1.2%,

which is approximately 3% in reactivity higher than the value predicted by multigroup theory. 22 references. (auth)

43711 (DP-Report-364) CALCULATIONS ON THE ZENITH REACTOR WITH PLUTONIUM FUELLED CORES. Project DRAGON. Drageset, A. (Atomic Energy Establishment, Winfrith (England)). Jul 1965. 73p. Dep. CFSTI.

Calculations on the experimental zero power reactor Zenith were carried out for two plutonium cores of widely different fissile/moderator atom ratio. The fuel contained only 2.49% of the ^{240}Pu isotope, though even at this rather low concentration, the reactivity held in the ^{240}Pu was about 5% in the harder spectrum core. The calculations cover the effective multiplication factor for the two cores and in case of the harder spectrum core also fission rate distributions and core and reflector temperature coefficients. Satisfactory agreement with experiment was obtained for the effective multiplication factors and the fission rates distributions. The core temperature coefficients are not directly comparable with experiments, because Doppler broadenings of resonances and thermal expansion of the reactor core were neglected in the calculations. The reflector temperature coefficients are 20 to 35% lower than experimental figures. 29 references. (auth)

43712 (DP-Report-402) ZERO POWER MEASUREMENTS OF THE TEMPERATURE COEFFICIENT OF THE FIRST DRAGON CORE. Project DRAGON. Blake, J. P. H.; Cameron, I. R. (Atomic Energy Establishment, Winfrith (England)). May 1966. 19p. Dep. CFSTI.

The isothermal temperature coefficient of the first Dragon core was measured over the temperature range from ambient conditions to a maximum temperature of about 185°C. The high temperature condition was achieved solely by running the primary circulators, so that precise zero power reactivity measurements based on the diverging period technique could be used throughout. An experimental reactivity difference of 1.22 ± 0.05% was measured, which compares with the theoretical prediction of 1.22 ± 0.03 over the same temperature range. The error quoted for the theoretical result takes account of the uncertainty in temperature measurement. 7 references. (auth)

43713 (DP-Report-406) THE SAFETY SUBMISSION FOR THE DRAGON TRANSFER FUNCTION ANALYSER. Project DRAGON. Blake, J. P. H. (Atomic Energy Establishment, Winfrith (England)). Feb 1966. 40p. Dep. CFSTI.

The Dragon Transfer Function Analyser is described, and its safety in operation is discussed. It is shown that the safety requirements for reactor operation are fulfilled for all credible faults on the T.F.A. Reactor operating instructions for the use of the T.F.A. are given. 7 references. (auth)

43714 (IN-1374) DIGITAL COMPUTATION OF POWER SPECTRAL DENSITY CURVES FROM REACTOR NOISE DATA. Kramer, Barry Jay (Idaho Nuclear Corp., Idaho Falls). Jun 1970. Contract AT(10-1)-1230. 199p. Dep. CFSTI.

The feasibility of doing power spectral density analysis of reactor noise data on a small general purpose digital computer was investigated. The fast Fourier transform algorithm of Cooley and Tukey was employed to transform data from the time to the frequency domain. A program was first written for the larger IBM-7044 computer which had sufficient core memory to transform up to 8192 discrete points. Results were confirmed by: an independent check and comparison of results obtained by analyzing the same data on an analog computer. Statistical properties of the noise data were also checked and it was found to be random, normally distributed and stationary. A similar program was written for a Digital Equipment Corporation PDP-9 computer with an 8K, 18 bit, memory and 128K RM09 serial drum. A Fortran version of the fast Fourier transform algorithm accomplished 256 and 512 point transforms in 8 and 17 seconds, respectively. It was estimated that the same program written in MACRO-9 (PDP-9 assembler language) could transform 256, 512 and 1024 points in 1.4, 3.2 and 7 seconds, respectively. All other portions of the power spectral density program, excluding the fast Fourier transform portion, can be accomplished in under 1 second. The results were accurate and fast enough to confirm the feasibility of using a small general purpose computer to make online, real time, power spectral density evaluations. (25 references) (auth)

43715 (NP-9831) A PROGRAM FOR HIGH TEMPERATURE REACTOR KINETIC CALCULATIONS ON THE FERRANTI MERCURY COMPUTER. Project DRAGON. Blake, J. P. H.; Crouch, E. G. H. (Atomic Energy Establishment, Winfrith (England)). Dec 1960. 43p. (DP-Report-10). Dep. CFSTI.

Methods of calculation of the kinetic behavior of the 10 MW High Temperature Reactor Experiment are given, together with a description of the corresponding MERCURY program and results for various transients. A revised correlation for the core heat transfer coefficient is included, and finite coolant transport delay times are considered. The program is also able to calculate the effect of primary circulator failure. (auth)

43716 (NP-10045) THE POWER STABILITY OF REACTORS OF THE DRAGON TYPE. Project DRAGON. Blake, J. P. H. (Atomic Energy Establishment, Winfrith (England)). Feb 1961. 57p. (DP-Report-19). Dep. CFSTI.

Two possible sources of power instability in reactors of the DRAGON type are considered, with particular reference to the DRAGON Reactor Experiment. They are: (1) interaction of core temperature coefficients; and (2) variation of ^{135}Xe concentration. The results indicate that the DRAGON Reactor Experiment is stable with respect to both phenomena. (auth)

43717 (NP-10432) THE MEASUREMENT OF PROMPT NEUTRON LIFETIME BY THE PERTURBATION TECHNIQUE THEORY AND APPLICATION TO THE ZENITH REACTOR. Project DRAGON. Tiren, L. I. (Atomic Energy Research Establishment, Harwell (England)). May 1961. 21p. (DP-Report-32). Dep. CFSTI.

The prompt neutron lifetime of the ZENITH reactor was determined by a static method which involves measuring the reactivity effect produced by the uniform insertion of a 1/v-absorber into the reactor. The theory underlying this experiment is discussed on a basis of multigroup perturbation theory. The theoretical and experimental limitations of the method are considered. The experimental value of the neutron lifetime obtained with the first loading of ZENITH agrees well with the result of a two group calculation carried out by means of the MERCURY digital computer. An analytical approach is made on a modified one group basis. The influence of a reflector on the prompt neutron lifetime is considered in particular. (auth)

43718 (NP-11064) XENON REACTIVITY VARIATIONS IN THE DRAGON REACTOR AFTER SHUTDOWN. Project DRAGON. Blake, J. P. H. (Atomic Energy Establishment, Winfrith (England)). Oct 1961. 19p. (DP-Report-59). Dep. CFSTI.

The form of the xenon transient after shutdown is calculated for the Dragon Reactor Experiment operating at 20 MW(t). It is found that less than 1.5% additional reactivity is involved in the transient. More general curves for the xenon transient are also given. These curves indicate the effect of changes in neutron flux and neutron temperature. 7 references. (auth)

43719 (RT/FI-(70)2) MODEL OF SELF-CONTROL OF BOILING IN EXCURSIONS OF WATER-COOLED REACTORS DURING OPERATION AT POWER. Michelini, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 26 Nov 1969. 80p. (In Italian). Dep. CFSTI (U. S. Sales Only).

A model of the boiling self-control in the excursions of zero power pool water reactors is reviewed. In order to evaluate the excursions of power reactors, the model is integrated with regard to the following points: fuel temperature distribution at the boiling first appearance; temperature of boiling first appearance; void volume; bubble lifetime; void carrying away; and forced convection cooling. 7 references. (auth)

43720 (RT/FI-(70)19) HETEROGENEITY EFFECTS ON THE ADJOINT FUNCTION AND RELATED QUANTITIES IN FAST REACTORS. Bitelli, G.; Cecchini, G.; Gandini, A. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Centro di Calcolo). [1970]. 19p. Dep. CFSTI (U. S. Sales Only).

A method using collision techniques is developed which accounts for the heterogeneity effects on the adjoint function in the cell structure of fast reactors. A numerical example is shown relevant to the sodium void experiments on assembly 4Z of the ZPR VI critical facility. 5 references. (auth)

43721 ABSOLUTE MEASUREMENT OF THE INTEGRAL SLOW-NEUTRON DOSE IN THE REACTOR CORE BY THE TRANSMISSION METHOD. Vertebnyi, V. P.; Zatserkovskii, R. A.; Kirilyuk, A. D. At. Energ. (USSR); 28: 149-50(Feb 1970). (In Russian).

A simple modification is proposed in the method used for determining neutron fluxes on the basis of the burnout by making use of the specific characteristics of the capture cross section and avoiding the necessity of using a mass spectrograph. The method requires measurement of the transmission of monochromatic neutrons through the specimen before and after irradiation. The monochromatic neutrons are separated out by means of a chopper with a 0.2 mm slit operated at 363 rpm. The boron and cadmium specimens were enclosed in a metal container, and were irradiated for 67 days at 11 MeV in the VVR-M reactor. Data on the transparency of ^{10}B indicated a flux of 4.3×10^{20} n. The flux may be determined in any of the beam holes of the reactor. The

method may be further simplified by eliminating monochromators or choppers and using a beryllium filter or taking advantage of the whole thermal spectrum by assuming that it possesses a Gaussian distribution. (TTT)

43722 MEASURING REACTOR NEUTRON FLUXES BY THE USE OF SUPERIMPOSED ACTIVATION FOILS. Biryukov, E. I.; Khramov, N. N.; Shimanskaya, N. S. At. Energ. (USSR); 28: 357-9(Apr 1970). (In Russian).

Thermal and epithermal neutron fluxes can be determined from activities induced in two elements having different reaction cross-sections for thermal and epithermal neutrons. Co–Au, Co–Na, Co–Cu and Co–Cs couples were used with and without a Cd filter. A scintillation γ spectrometer was used to measure the induced activities. The results obtained by the use of two activation foils agreed well with the results obtained from the Cd difference. The use of ^{64}Cu, ^{24}Na and ^{198}Au is not always convenient because of the short half-life of the induced activity. For measuring large integral fluxes over a long irradiation period it is better to use the Co–Cs couple. The induced ^{134}Cs activity has a relatively long half-life of 2.05 yr, and the ratio of the thermal neutron capture cross-section to its resonance integral (0.073) differs substantially from this ratio in Co (0.484). Integral neutron fluxes on the order of 10^{20} and 10^{22} neutrons/cm^2 can be measured by use of the Co–Cs couple. (TTT)

43723 DETERMINING THE REACTIVITY RESERVE. Shulepin, V. S.; Matveenko, V. I. At. Energ. (USSR); 28: 355(Apr 1970). (In Russian).

In order to determine experimentally the reactivity excess of a reactor with a water moderator, a method based on single-group diffusion theory is ordinarily used. The change in reactivity with height is measured for a number of critical values of the height, and the reactivity excess is determined by integration. In the presence of reflectors, corrections must be introduced in order to decrease the error. The correction is made as the difference between the true reactivity excess and the experimental reactivity excess. An example of the calculation of the reactivity excess is demonstrated for a reactor without a reflector and a reactor with infinite reflectors. (TTT)

43724 VARIATIONS IN NEUTRONIC CHARACTERISTICS ACCOMPANYING BURNUP IN A LARGE FAST CONVERTER. Yamashita, Shizuo (Sumitomo Atomic Energy Industries, Ltd., Tokyo). J. Nucl. Sci. Technol. (Tokyo); 7: 341-54(Jul 1970).

With the aim of finding a good Pu producing reactor, criticality and burnup calculations have been performed on a large fast converter, which is fueled with enriched UO_2 pellets instead of mixed PuO_2–UO_2 pellets in the pancake-shaped core of 1,000 MW(e) Na-cooled fast breeder. The characteristics of the fast converter have been found to be as follows: the enrichments of the initially loaded fuel are 22.3% in the inner core and 25.8% in the outer; the fresh fuel used for refueling requires enrichments of 26.3% and 30.4% for the inner and outer cores, respectively; and when a refueling cycle is repeated under the assumption that the refueling scheme for this fast converter is in 4 batches for both inner and outer cores at 6-month intervals, the total conversion ratio is about 0.8, the Na void effect changes from $-0.82\ \Delta k/k\%$ to $-0.26\ \Delta k/k\%$ during the period to equilibrium (calculated for the case of complete Na removal from core), and the Doppler coefficient increases from -0.0032 to $-0.0029(T \cdot dk/dT)$ during the same period (with Na). The fast converter is shown to be a good Pu-producing reactor when compared with thermal reactors, and to be a fast reactor which can be operated safely from the standpoint of neutronic characteristics. (12 references) (auth)

Control Systems

43725 (CEA-R-3890) CONTRIBUTION TO THE STUDY OF THE STABILITY OF WATER-COOLED REACTORS. Coudert, Claude (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Oct 1969. 185p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Faculte des Sciences, Univ. of Aix-Marseilles, France.

A study of the stability of reactors cooled by water subjected only to natural convection is presented. It is made up of two parts, a theoretical study and experimental work, each of these parts being devoted to a consideration of linear and non-linear conditions: (1) calculation of the transfer function of the reactor using neutronic and hydrodynamic linear equations. Determination of the instability threshold; (2) demonstration of the existence of the limiting oscillation cycle in the case of a linear feedback using Malkin's method; (3) measurement and interpretation of the reactor's transfer functions and of the hydrodynamic transfer functions; and (4) analysis of the noise due to boiling. (auth)

43726 (NP-9879) THE CONTROL OF THE DRAGON REACTOR EXPERIMENT AT LOW POWER LEVELS. Project DRAGON. Blake, J. P. H. (Atomic Energy Establishment, Winfrith (England)). Jan 1961. 16p. (DP-Report-15). Dep. CFSTI.

The reactor periods for low power operation with the existing control mechanisms are calculated. The effect of delayed neutrons results in long reactor periods, which are safe and convenient from an operational viewpoint. (auth)

Shielding

Refer also to abstract 42302.

43727 (CEA-N-1311) THE ORPHEE D PROGRAM. FAST NEUTRON ATTENUATION IN A LAMELLAR STRUCTURE MADE UP OF WATER AND A DENSE MATERIAL. Dupont, Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1970. 22p. (In French). Dep. CFSTI (U. S. Sales Only).

The fast neutron flux in the side protection of a light water reactor is calculated by the ORPHEE D program. Attenuation in water is treated according to the formalism of a nucleus in water; this is different to the straight-line attenuation used for dense materials. The code also makes it possible to use, without modification, the radial power distribution maps provided by the Mathematical Physics Service at Saclay. (auth) (France)

43728 (JPRS-51083) PROBLEMS IN THE PHYSICS OF REACTOR SHIELDING. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Translation of selected papers from Voprosy Fiziki Zashchity Reaktorov, Vypusk 4, Atomizdat, Moscow, 1969. 251p. CFSTI.

Twenty-one articles are included on the theoretical and experimental data on nuclear reactor radiation shielding. Results are given on studies of spatial, energy, and angular distribution of radiation in various homogeneous and nonhomogeneous shieldings. Albedo problems in the transport theory, extraction cross sections in homogeneous water bearing media, studies of fast neutron transport by means of multigroup system of integral equations, 0.9 MeV neutron penetration through biological shielding, formation of fast neutron spectra in various shielding material, shielding properties of metallic Li, and measurements of neutron spectra in a wide range of energies are discussed. Slow neutron concentration in homogeneous media, energy distribution of epithermal neutron flux in stainless steel and Ti, attenuation of reactor radiation in cylindrical and annular water channels, γ-radiation from the Po–α–Be source with E = 4.43 MeV penetration through graphite channel inverse scattering of neutron and γ-radiation in nonhomogeneous shielding and single-rate diffusion of neutrons in nonbreeding two-dimensional systems with cylindrical symmetry and use of multigroup methods for calculating of neutrons in nonhomogeneous shielding are reviewed and analyzed. (R.V.J.)

Cooling Systems

Refer also to abstracts 41173, 41180, 41391, and 41602.

43729 (ANL/ST-2) SODIUM TECHNOLOGY QUARTERLY REPORT, JANUARY–MARCH 1970. Ader, M.; Kesser, G. (comps. and eds.) (Argonne National Lab., Ill.). Jul 1970. Contract W-31-109-eng-38. 95p. Dep. CFSTI.

The research, development, and management efforts are reported in the following areas: development and testing of on-line instrumentation for monitoring oxygen, carbon, and hydrogen in LMFBR sodium and for detecting leaks in LMFBR steam generators; drafting of a program for setting up standard analytical methods to meet the needs of the national sodium technology effort, and the development of methods for the determination of trace amounts of oxygen, carbon, nitrogen, and metallic impurities in sodium; definition of problems created by the radioactivity in the primary sodium system and cover gas of reactors, the development of means to detect and evaluate fuel failures, and a study of the kinetics and mechanism of formation of sodium aerosol; studies of the transport of carbon in sodium-steel systems and of the adequacy of vanadium alloys as cladding for LMFBR fuels; development of purification methods for removing contaminants from primary coolant sodium; and studies of the chemistry of carbon- and nitrogen-bearing species in liquid sodium and of the solubility of xenon. (auth)

43730 (APDA-257) PROJECT SUMMARY, SODIUM-WATER REACTIONS RELATED TO LMFBR STEAM GENERATORS. Chamberlain, H. V. (Atomic Power Development Associates, Inc., Detroit, Mich.). Jun 1970. Contract AT-(11-1)-865. 63p. Dep. CFSTI.

Sodium-water reactions are investigated relative to the development of safe, reliable, and economic Na heated steam generators for the LMFBR program. This program included the development of: data needed to estimate the extent of tube wastage and to determine the dominant system parameters affecting tube wastage during a small leak of water into Na; criteria needed to evaluate systems for detecting a small leak of water into Na; and a mathematical model for predicting the behavior of large Na-water reactions in a Na-heated steam generator. (34 references) (auth)

43731 (CEA-R-4012) CYTHERE CODE: KINETICS OF THE SECONDARY WATER-STEAM CIRCUIT OF A GAS-COOLED NUCLEAR REACTOR. Rousseau, Jean-Claude; Barber, Pierre; Dobremelle, Michel; Villard, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1970. 43p. (In French). Dep. CFSTI (U. S. Sales Only).

A numerical method is presented for calculating the transient phenomena in the secondary water-steam circuit of a gas-cooled nuclear reactor. The basis of this method is to consider the space and the time discreetly. The partial derivative equations representing the conservation of energy, of mass, and of momentum are then replaced by finite difference equations. This calculation code is compared to test results obtained with the prototype of a steam generator designed for a gas-graphite reactor. It appears that the code explains perfectly well the changes in all the physical parameters of the primary and secondary fluids for regimes in which occur sudden and large changes of the conditions. (auth)

43732 (DP-Report-367) PROPOSALS FOR THE PERIODIC INSPECTION OF THE PRESSURE CONTAINMENT SYSTEM AND ASSOCIATED PLANT AND EQUIPMENT OF THE DRAGON REACTOR. Project DRAGON. Conde, J. F. G. (Atomic Energy Establishment, Winfrith (England)). Aug 1965. 114p. Dep. CFSTI.

The basic considerations governing the formulation of the proposals for operational inspection of the Dragon Reactor are described and the datum points for the inspection cycles on the various areas of plant are defined. The proposed cycle of inspection is correlated with the tentative reactor core program for the first two years of operation. Proposals for operational inspection are detailed together with a brief indication of the underlying reasons for the various operations and their feasibility and safety. The need to observe the normal safety precautions when carrying out the proposed inspection operations is emphasized as is the need to keep the proposals under review and to revise them in the light of experience. (auth)

43733 (DP-Report-383) CARBON TRANSPORT IN A HTGCR POWER PLANT. Project DRAGON. Valette, L. (Atomic Energy Establishment, Winfrith (England)). Oct 1965. 32p. Dep. CFSTI.

A mathematical model is established in order to predict the steady state equilibrium concentration of the chemical impurities in a HTGR primary circuit in which a small leak has developed. The maximum admissible water inleakage in the circuit is derived from the steady concentration of impurities and from the maximum admissible damage to the graphite components. A parametric study of the factor influencing the maximum admissible water inleakage is performed and for illustration purposes specific cases based on the UKAEA/HTR reference design study, and on AGIP/INDATOM study are calculated. From this study recommendations for the RD work and for the HTGR engineering design are drawn. 8 references. (auth)

43734 (EURFNR-784) FLOW INDUCED TEMPERATURE AND PRESSURE PULSATIONS IN ROD BUNDLES. Kadlec, J.; Lang, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Apr 1970. 20p. (KFK-1157; SM-130/41; CONF-700307-6). Dep. CFSTI (U. S. Sales Only).

Work performed under United States-Euratom Fast Reactor Exchange Program.

From Symposium on Progress in Sodium-Cooled Fast Reactor Engineering, Monaco.

Experiments are described, which are carried out to investigate the random pressure and temperature pulsations of a coolant flow and their consequences. Water circuit experiments with a fuel subassembly provided an indication of the correlation between pressure fluctuations and vibrations of the fuel pins. The temperature pulsations were investigated in a sodium loop. A description is given of the test facilities and the test results. 10 references. (auth)

43735 (NP-10078) FISSION PRODUCT DEPOSITION IN DRAGON UNDER NORMAL OPERATION. Project DRAGON. Schmidt, H.; Fullom, S. (Atomic Energy Establishment, Winfrith (England)). Mar 1961. 14p. (DP-Report-20). Dep. CFSTI.

The deposition of fission products at various points of the plant was estimated in order to make the necessary provisions for maintenance and repair. Three main questions were considered: (1) The deposition in the main cooling circuit and on the adjacent surfaces. (2) The deposition in a by-pass stream of the main cooling circuit. (3) The deposition in the inner containment. A list is given of the most important γ emitters together with their activities in the cooling circuit assuming rapid deposition. An estimate is obtained of the deposition in the heat exchangers and in the duct leading to the heat exchangers. The shielding of the heat exchangers is also considered. An estimate is given of the activity likely to be found in any by-pass stream of the main cooling circuit, e.g., at the charge machine or at the top plug. An attempt is made to find the maximum possible deposition in the inner containment making certain pessimistic assumptions. 6 references. (auth)

43736 (NP-10263) THE LEAK-TIGHTNESS OF DEMOUNTABLE FLANGE ASSEMBLIES USING SOFT IRON GASKETS. Project DRAGON. Pollitt, N. (Atomic Energy Establishment, Winfrith (England)). Apr 1961. 40p. (DP-Report-28). Dep. CFSTI.

The vacuum leak-tightness of demountable flange assemblies, 5 inches in diameter, was investigated experimentally over a range of temperatures to a maximum of 600°C. The seal was formed by using a 2 inch diameter soft iron gasket 0.018 inch thick half-trapped between two stainless steel flanges having sealing lips 0.005 inch high machined on their faces. No difficulty was experienced in achieving a leakage rate as low as 0.1 clusec at temperatures below 450°C. Between 450°C and 600°C it was found necessary to use Nimonic 80 bolts because of the problem of creep. Under these conditions the leakage rate at 600°C was approximately 3 clusec. Attempts were made to estimate the effect of gas pressure on the leakage rate of gases from pressurized systems. 6 references. (auth)

43737 (NP-10678) LEAK TESTING OF THE TEST VESSEL AND EXPERIMENT GASKETS AT MANNESMANN, HUCKINGEN, WEST GERMANY. PART 2. Project DRAGON. Barnes, D.; Wade, F. (Atomic Energy Establishment, Winfrith (England)). Jul 1961. 10p. (DP-Report-44). Dep. CFSTI.

Part 1 was published in DP-Report-23 (NP-10129).

The results of the second phase of the experimental work carried out on the Test Vessel at Mannesmann, West Germany during the period 5th December, 1960 to 9th February, 1961, are specified and reported. (auth)

43738 (NP-10679) PRELIMINARY REPORT ON STACK WIND TUNNEL TESTS. Project DRAGON. Coudray, M. A.; Bateman, A. (Atomic Energy Establishment, Winfrith (England)). Aug 1961. 12p. (DP-Report-49). Dep. CFSTI.

Four types of stack exit geometries were tested: three types of cowl and a plain tube. The following parameters were taken into consideration: wind velocity, stack exit velocity, cooler exit velocity, and wind direction. A cowl type 140 ft to the north and 54 ft to the east of the reactor, with a height of 32 meters, and an exit velocity of 90 ft/sec, is proposed. (M.C.G.)

43739 (NP-10869) SOME QUANTITATIVE REMARKS ON LEAK RATE MEASUREMENTS. Project DRAGON. Nullens, G. C. (Atomic Energy Establishment, Winfrith (England)). Aug 1961. 17p. (DP-Report-41). Dep. CFSTI.

A simple method to determine the leak rate of a component subject to a high internal pressure is to connect it to a pressure gauge and measure the pressure change during a given period of time. An analysis shows that to obtain accurate measurements of leak rates of the order of 10^{-5} atmos cc/sec rather long time intervals are needed. A modification of this technique which can save considerable time is also discussed. A brief description is given of applications of the helium mass spectrometer for leak rate measurements. An evaluating comparison with the pressure drop methods is also given. (auth)

43740 (NP-10870) HEATING EXPERIMENT WITH BOLT FOR THE PRESSURE VESSEL MAIN FLANGE. Project DRAGON. Hansen, K. (Atomic Energy Establishment, Winfrith (England)). Aug 1961. 11p. (DP-Report-50). Dep. CFSTI.

In order to be able to tighten the main flange bolts to the proper stress, the bolts will be heated by heaters placed in the hollow bolts. The extension obtained by heating allows the nuts to be turned a predetermined angle. By contraction against the flange during cooling down the bolts are loaded to the proper stress.

This experiment gives the relationship between the power input to the heater, the time for heating and the extension of the bolt. (auth)

43741 (NP-10874) APPROXIMATE HEAT TRANSFER AND PRESSURE DROP CHARACTERISTICS OF A DRAGON CHANNEL. Project DRAGON. Husain, L. A. (Atomic Energy Establishment, Winfrith (England)). Sep 1961. 12p. (DP-Report-54). Dep. CFSTI.

A simple method of estimating heat transfer and pressure drop conditions in a channel is described. Curves are presented for the Dragon channel geometry. Comments are made concerning N_2 operation of the 7-element experiment. 5 references. (auth)

43742 (NP-18331) MEETING OF SPECIALISTS ON SODIUM VAPOUR CONTROL, CADARACHE, FRANCE, 19-20 MARCH 1970. (International Atomic Energy Agency, Vienna (Austria)). 26p. Dep. CFSTI (U. S. Sales Only).

Information related to the characteristics and control of Na vapor in liquid metal-cooled fast reactor cooling systems is presented. Problems with cool gas systems are discussed. (D.C.C.)

43743 TRITIUM EXTRACTION FROM HEAVY WATER IN NUCLEAR REACTORS. Leger, D.; Dirian, G.; Roth, E. (CEN de Saclay, Gif-sur-Yvette, France). Energ. Nucl. (Paris); 12: 135-42(Mar-Apr 1970). (In French).

In order to eliminate tritium from heavy water in nuclear reactors, a continuous extraction process was developed. The method based on a catalytic exchange of tritium with deuterium followed by a distillation of deuterium is described. Calculations were made concerning the installation of this process in the high flux reactor at Grenoble. (auth) (France)

43744 EQUIPMENT FOR THE FAST REACTOR PROGRAM. Raczynski, Wladislaw (SNECMA, Suresnes, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 82, 17-23(Mar-Apr 1970). (In French).

The main features of the work carried out on the equipment for the test installations and for the reactors during the last decade are described. The interest is limited to liquid metal pumps and to handling devices. (France)

43745 REMOVAL AND REPLACEMENT OF EXPERIMENTAL PRESSURE TUBES IN THE WINFRITH SGHWR. Cartwright, H.; McKeague, R.; Smith, D. (United Kingdom Atomic Energy Authority, Risley, Eng.). Atom (London); 164: 131-8(Jun 1970).

One of the important engineering features of the SGHWR is the easy access to components of the core structure, and the ability to change these, even after a significant period of irradiation, if the need should arise. An example of this occurred during a planned shutdown for maintenance and refueling. Six experimental channel units were removed and replaced. The operation was extremely interesting technically and provided a practical demonstration of this outstanding advantage of the SGHWR. (auth) (UK)

43746 CIRCULATION AND AUXILIARY PUMPS FOR HIGH POWER NUCLEAR BOILERS. Forien, Michel; Lepert, Claude (Etablissements Pompes Guinard, Saint-Cloud, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 82, 5-8(Mar-Apr 1970). (In French).

Pumps for water reactors, for auxiliary circuits of nuclear installations and liquid metal pumps are discussed. The various aspects of interest to constructors and users concerning the choice of equipment for the various circuits are briefly examined: performance, investment, operating costs, safety, reliability and servicing. (auth) (France)

43747 UNSTATIONARY THERMAL FIELD OF A NUCLEAR REACTOR WITH CYLINDRICAL CORE. Hermansky, Bedrich (Technical Univ., Prague). Jad. Energ.; 16: 221-8(Jul 1970). (In Czech).

The solution of unstationary heat transfer equations for a fuel channel of a two-component power reactor having constant cooling medium flow is given using a simple Laplace transformation. The basic transfer functions of a fuel channel are derived, a convenient transfer approximation of a fuel channel is referred, and in the form of convolutory integrals the unstationary thermal field having source in the change of the inlet cooling medium temperature, and thus of the reactor power, is described. In the approximation of axial parameter distribution, some results of numerical calculation with constants corresponding to the fuel channel of the KS-150 reactor are given. (auth)

43748 STEAM/WATER SEPARATORS FOR BOILING WATER REACTORS. Vollradt, J. (AEG-Telefunken, Frankfurt am Main). Kerntechnik; 12: 283-90(Jul 1970). (In German and English).

In boiling water reactors a steam separation step must be intercalated before the steam drying in order to prevent steam carry-under into the downcomer. The steam content of the return flow of recirculating water upstream of the feedwater inlet should not exceed 0.5% by mass. Natural separation by gravity forces is insufficient for modern large power reactors. Various separator types and their development are described. Measurements carried out in the course of commissioning of the first two reactors with internal forced steam/water separation are presented. The pressure loss in the steam separators of KWL and KRB amounts to about 0.4 kgf/cm², corresponding to about 20% of the total pressure loss in the recirculation cycle. (7 references.) (auth)

Fuels

Refer also to abstracts 41210 and 42285.

43749 (BNWL-1103) PROPOSAL TO IRRADIATE UNENCAPSULATED PINS IN THE EBR-II SUBASSEMBLIES PNL-6, PNL-7, AND PNL-8. Ballard, E. O.; Pember, L. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 257p. Dep. CFSTI.

Three unencapsulated, 37-pin subassemblies will be irradiated in the EBR-II in support of the FFTF Driver Fuel Development Program. The fuel pin parameters will be typical of proposed FFTF fuel pin designs. The pins will be irradiated under conditions approximating as nearly as possible those proposed for the FFTF. These pins will operate at linear heat ratings between 6 and 15 kW/ft to exposures of 80,000 MWd/MTM. The fuel will be solid pellets with a nominal fuel smeared density of 88% TD. The primary objective is to obtain statistically significant data on swelling behavior, gas release rates, and general irradiation performance of pins fabricated with typical FTR fuel pin parameters and tolerances and irradiated under approximately FTR conditions. (auth)

43750 (BNWL-1420) PROPOSAL TO IRRADIATE UNENCAPSULATED INSTRUMENTED FUEL PINS IN THE EBR-II SUBASSEMBLY PNL-17. Ballard, E. O.; Millhollen, M. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 256p. Dep. CFSTI.

A 37-pin, instrumented subassembly will be irradiated in the EBR-II in support of the FFTF Driver Fuel Development Program. The pins will be unencapsulated and parameters will be typical of proposed FFTF fuel pin designs. The pins will be irradiated under conditions approximating as nearly as possible those proposed for the FFTF. They will operate at a maximum linear heat rating of approximately 12 kW/ft (62.5 MW reactor power) to an exposure of approximately 10-20,000 MWd/MTM. The fuel will consist of pressed and sintered UO_2-PuO_2, cylindrical pellets with a theoretical density of 93 ± 2%. The principal purpose of this test is to determine the coolant flow-heat balance characteristics of a 37-pin subassembly in a manner to allow confirmation of calculational methods applied to other irradiation test assemblies. A secondary purpose of the test is to determine the validity of the use of silicon carbide as a temperature monitor within fuel pins. (auth)

43751 (BNWL-1435) CERAMIC FUELS FOR HEAVY WATER REACTORS. Anicetti, R. J. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 81p. Dep. CFSTI.

Ceramic oxide fuels have achieved a commanding lead for water cooled reactor fuels. Fuel fabrication technology, fuel irradiation behavior and limitations for these materials are summarized. Information presented covers work since 1964. Most oxide fuel fabrication and irradiation experience are valid for all water reactor fuels, including heavy water reactors unless otherwise specified. (152 references.) (auth)

43752 (CEA-N-1329) EXPERIMENTAL STUDY OF A GAS FLOW NEAR A FLAT SURFACE FITTED WITH FINS INCLINED WITH RESPECT TO THE DIRECTION OF GAS FLOW. Juignet, Nicole (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1970. 108p. (In French). Dep. CFSTI (U. S. Sales Only).

In nuclear gas-graphite power reactors, the heat exchange between fuel elements and cooling gas was improved by use of cylindrical cans fitted with cooling fins in a herring-bone pattern. An experimental study was made of the gas flow by analyzing the distribution of velocity vectors between the fins and the main gas flow; this was done on a full-scale model of a section of the can. These aerodynamic study and heat transfer tests showed the origins of the thermal anomalies observed on these surfaces and

their distribution law along a set of cartridges. A study was also made of the influence of the size of the slot between the can sectors and of the channel diameter on both the thermal anomalies and on the average exchange coefficient level. (7 references) (auth) (France)

43753 (DP-Report-196) PROCEEDINGS OF THE DRAGON PROJECT FUEL ELEMENT SYMPOSIUM HELD AT THE BOURNE HALL HOTEL, BOURNEMOUTH, ON THE 28th AND 29th JANUARY 1963. Project DRAGON. (Atomic Energy Establishment, Winfrith (England)). Jun 1963. 31p. (CONF-630103-1). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

The discussions which followed the presentation of papers at the Dragon Project Fuel Element Symposium are presented. The papers presented are shown in the Symposium Programme and this, together with a list of participants, is included. (auth)

43754 (DP-Report-244) LOOP IRRADIATIONS AND RADIOCHEMICAL EXAMINATION OF IRRADIATED FUEL COMPONENTS AT STUDSVIK. Project DRAGON. Hammar, L.; Svensson, P. (Atomic Energy Establishment, Winfrith (England)). Nov 1963. 47p. (CONF-631115-2). Dep. CFSTI.

From Symposium on Post Irradiation Studies on Fuel, Harwell, Eng.

The fission product emission loops in the reactor R2 at Studsvik, Sweden are described in some detail. The methods of analyzing noble gases and halogens emitted from the fuel are presented and typical experimental results are shown. The methods of radiochemical examination of fuel components are described: sampling, remote handling techniques, radiochemical separations, and burnup measurements. The results of fission product migration in rigs irradiated at Risø, Denmark, are summarized. (17 references) (auth)

43755 (DP-REPORT-284) THERMAL AND ELECTRICAL CONDUCTIVITIES OF DRAGON FUEL CARTRIDGES. Project DRAGON. Milne, J. M. (Atomic Energy Establishment, Winfrith (England)). Jun 1964. 20p. (CONF-638-5). Dep. CFSTI.

From National Physical Laboratory Conference on Thermal Conductivity, Teddington, Eng.

The apparatus and method of measuring the thermal and electrical conductivities of Dragon Reactor fuel cartridges over the temperature range 950–1500°C are described. (auth)

43756 (DP-Report-365) SOME ASPECTS OF CARBON TRANSPORT IN HIGH TEMPERATURE GAS COOLED REACTORS. Project DRAGON. Everett, M. R.; Kinsey, D. V. (Atomic Energy Establishment, Winfrith (England)). Aug 1965. 57p. (CONF-650632-20). Dep. CFSTI.

From 7th Biennial Conference on Carbon, Cleveland.

The corrosion of graphite by small quantities of oxidizing impurities in He has been studied both out-of-pile and in an in-pile loop. To provide more data and to avoid interference from side reactions with the materials of the loop, ^{14}C labelled graphite samples have been used to supplement the information gained from normal gas analytical equipment. For the results obtained from the in-pile loop experiments a theoretical model is proposed which explains the large departure of the observed reaction rate from first order dependence on CO_2 concentrations for the temperature range 250 to 900°C. Other aspects of graphite corrosion in a high temperature He cooled graphite moderated reactor are briefly considered. Carbon deposition reactions on catalytically active surfaces have been studied experimentally over the temperature range 200 to 700°C. Gas equilibria limiting the system for iron surfaces are considered and found to explain the experimentally observed distribution of deposited carbon with respect to temperature. The effects of carbon deposition on steel surfaces and the nature of the deposited carbon have been studied. Observed rates of carbon deposition when extrapolated to power reactor conditions indicate the possibility of large increases in graphite corrosion rates caused by regeneration of oxidizing impurities, if no special measures are taken. A new mathematical approach to design and operational aspects of carbon transport in high temperature gas cooled reactors is presented. (auth)

43757 (DP-Report-377) THE DRAGON IRRADIATION PROGRAMME IN RETROSPECT. Project DRAGON. Saunders, R. A. (Atomic Energy Establishment, Winfrith (England)). Sep 1965. 29p. (CONF-650972-2). Dep. CFSTI.

From European Atomic Energy Society Symposium on Irradiation Experiments, The Hague.

The Dragon Project has been concerned with design, construction and operation of a 20 MW High Temperature Gas Cooled Reactor. Part of the supporting Research and Development Program has been a series of irradiation experiments in the various member countries. Because of the nature of the fuel the irradiation rigs have in most cases been of a specialized type and the several designs are briefly described. The cost and scale of the program is considered and an attempt made to relate the usefulness of various rig types to the actual costs. In reviewing the Project's experience in the field of irradiation, the philosophy behind the irradiation program is discussed, and the relative merits of a variety of facilities and techniques considered. (8 references) (auth)

43758 (DP-Report-408) TESTING AND EVALUATION OF REACTOR FUEL PARTICLES. Project DRAGON. Koss, P.; Bildstein, H. (Atomic Energy Establishment, Winfrith (England)). Feb 1966. 34p. Dep. CFSTI.

The results of xenon release measurements performed on Dragon production samples are reported. Reactivation analysis is performed on the B 2 compact from Studsvik 5. It is shown that R/B values obtained by this method are in very good agreement with the results of the loop (2×10^{-4}). The number of broken particles was determined by chlorination after electrolytical disintegration of the compact. Whereas the results of xenon release measurements seem to indicate 1 to 2 broken particles, the results of gas leaching correspond to about 60. This discrepancy clearly shows the influence of the graphite matrix on the fission product retention. (4 references) (auth)

43759 (DP-Report-413) FISSION GAS RELEASE FROM HIGH BURN-UP CARBIDE FUEL KERNELS. Project DRAGON. Rose, K. S. B.; Clough, D. J. (Atomic Energy Research Establishment, Harwell (England)). Mar 1966. 24p. (AERE-R-5160). Dep. CFSTI.

The stable fission gas release from fuel kernels in intact coated particles was measured by cracking open the coatings after irradiation and counting the ^{85}Kr released. Results from UC_2 showed a marked increase in ^{85}Kr release from the kernel (2% to 40%) between 4.3 and 6.6% burn-up, release levels being relatively insensitive to irradiation temperature in the range 925 to 1,275°C. A wide variety of other carbide kernels below 3% burn-up gave release levels of less than 2% over a wide temperature range. Results from sintered $(Th,U)C_2$ showed an increase in release with burn-up, however, temperature and burn-up effects cannot be separated because of the large range of irradiation temperature. The pressure exerted on the UC_2 particle coatings was measured by a radiographic technique as 11–23 atmospheres at an irradiation temperature of 1000°C. 15 references. (auth)

43760 (DP-Report-417) THE THERMAL EXPANSION CHARACTERISTICS OF FUEL MATERIALS FOR THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Milne, J. M.; Weeden, A. (Atomic Energy Establishment, Winfrith (England)). Apr 1966. 58p. Dep. CFSTI.

The design and construction of a high temperature furnace and dilatometer to measure the dilatation axially and diametrically of Dragon fuel cartridges are described. Additional measurements are reported on a variety of graphite matrices and fuel structures to be employed in the second charge of the Reactor Experiment as well as on standard and experimental graphites. (auth)

43761 (EURFNR-745) METHOD FOR THE EXPERIMENTAL INVESTIGATION OF FLOW-INDUCED FUEL ROD OSCILLATIONS. Kadlec, J.; Appelt, K. D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK-1082. 65p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Experimental investigation of hydrodynamically induced lateral vibrations of pins of fuel subassembly with many spacer grids is described. The proposed investigation method is based on the determination of the spectral density function of the bending strain at one location of the pin, which is used as a basis for calculation of spectral density functions of the displacement or of the bending stress at other locations of the pin. The proposed procedure was used for the investigation of parallel flow-induced-vibration of pin of the subassembly model of the Na 1 fast breeder reactor study. The experimental setup and the digital data acquisition system are described. The RMS-values as well as the spectral density functions of the lateral vibration of the fuel pin and of the whole subassembly, as well as of the boundary layer pressure fluctuations at the subassembly wall, are presented. 13 references. (auth)

43762 (GEAP-10028-33) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Thirty-Third Quarterly Report, November 1969–January 1970. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb 1970. Contract AT(04-3)-189. 128p. Dep. CFSTI.

FAST CERAMIC REACTOR—fuel elements for, development during November 1969 to January 1970
—core for, design and kinetics analyses of
—safety of, transient overpower and coolant loss flow effects on
INCOLOY 800—radiation effects on fast reactor fuel element cladding
PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, radiation effects testing of fuels of
—PuO_2–UO_2, properties of fuels of, mechanical and physical
REACTOR FUEL ELEMENTS—cladding for mixed oxide fast, development and testing of
—performance of defected mixed oxide, in flowing sodium
—performance of mixed oxide, effects of fuel, sodium, fission product, and cladding compatibility on
—radiation effects testing of mixed oxide fast
REACTOR SAFETY—transient overpower and coolant loss flow effects on ceramic fueled fast
STAINLESS STEEL—radiation effects on fast reactor fuel element cladding
URANIUM OXIDES UO_2—PuO_2–UO_2, radiation effects testing of fuels of
—PuO_2–UO_2, properties of fuels of, mechanical and physical (H.D.R.)

43763 (GEAP-13598) DESIGN AND ANALYSIS OF SEFOR CORE I. Meyer, R. A.; Reynolds, A. B.; Stewart, S. L.; Johnson, M. L.; Craig, E. R. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Jun 1970. Contract AT(04-3)-540. 286p. Dep. CFSTI.

The thermal-hydraulic, mechanical and neutronic analysis and design of SEFOR Core I is described. Both the static and transient aspects of the reactor operation are considered in the analysis of fuel rod and core structure behavior. Design details of the fuel rod and core hardware are presented together with a mechanical design evaluation. (auth)

43764 (IAE-1893) INVESTIGATION OF THE GROWING NON-HERMETICITY OF FUEL ELEMENT CANS BY MEANS OF ^{85}Kr. Kotelnikov, G. A.; Leonov, V. F. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1969. 12p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The process of development of non-hermeticity of U–Al fuel element cans has been investigated in the water coolant flow with transfer time about 10 min. The gaseous fission product, ^{85}Kr, has been used for the indication of non-hermeticity. The γ-radiation from ^{85}Kr has been recorded by the γ-spectrometry method and also in the counting regime by means of an integral discriminator set to the energy above 1.6 MeV. During the transition process of increasing the reactor power up to the preset level the pulse outflow of ^{85}Kr was observed. The amplitude of activity pulses increased after the reactor operated for a long time at the zeropower. In the stationary conditions the ^{85}Kr activity level varied only slightly. 9 references. (auth)

43765 (NP-9981) ON THE STABILITY OF FLAT PLATES UNDER THE INFLUENCE OF COOLANT FLOW. Project DRAGON. Schlosser, J. (Atomic Energy Establishment, Winfrith (England)). Feb 1961. 14p. (DP-Report-17). Dep. CFSTI.

The mechanical stability of a flat plate between two solid walls under the influence of a coolant flow is investigated. The gas flow is assumed to be viscous and turbulent, but temperature effects are neglected. By introducing the natural frequency of the rod as a general parameter, a qualitative picture of the phenomenon in Dragon fuel rods should be obtained. 4 references. (auth)

43766 (NP-10468) RADIOGRAPHIC INSPECTION FOR DRAGON FUEL ELEMENT GRAPHITE. Project DRAGON. Beutler, H.; Grant, R. L. (Atomic Energy Establishment, Winfrith (England)). Jun 1961. 19p. (DP-Report-38). Dep. CFSTI.

The use of radiographic inspection as a means of detecting defects in fine grain graphite material is described. Experiments to determine limits due to sensitivity and efficiency are discussed and the results obtained during preliminary inspection work are included. (auth)

43767 (ORNL-TM-2859) RESULTS FROM IRRADIATION TESTING OF UO_2 FUEL PINS DESIGNED FOR THE MEDIUM POWER REACTOR EXPERIMENT. Weaver, S. C.; Fitts, R. B.; Thoms, K. R.; DeCarlo, V. A.; Senn, R. L.; Scott, J. L. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 69p. Dep. CFSTI.

Four UO_2 fuel pins clad with stainless steel were tested in the Oak Ridge Research Reactor at linear heat ratings of 4.3 to 4.9 kw/ft, a cladding temperature of 830°C, and a fuel-center temperature of about 1400°C. Two of these fuel pins were prototypes for the Medium Power Reactor Experiment, while the other two contained extensometers to measure the change in the length of the fuel column as a function of time and burnup. The pins were fueled with 0.456- or 0.458-in.-diam × 0.500-in.-long UO_2 pellets that were pressed and sintered to 93% of theoretical density and clad in type 304 stainless steel. One prototype pin and one pin with an extensometer operated for 17,000 hr to a burnup of 1.20 at. % U. All four pins operated without failure and all increases in pin diameter were less than 0.2%. The maximum fission gas released was an unexpected high of 13.1% after 17,000 hr. A potentially serious ratchetting problem occurred in the 17,000-hr extensometer test. The fuel column length shrank 0.048 in. during the first 3800 hr, increased 0.010 in. during the next 10,000 hr, and then began to increase very rapidly; during the last 3200 hr, the length increased 0.138 in. When the fuel column reached this length, the extensometer went off scale, and the capsule was removed from the reactor. Postirradiation examination revealed that part of the top pellet had separated from the rest of the fuel column and moved up the cladding. (auth)

43768 PRESSURISATION IMPROVES FUEL ROD RELIABILITY. Ferrari, H. M. (Westinghouse Electric Corp., Pittsburgh). Nucl. Eng. Int.; 15: 623-5(Jul-Aug 1970).

In-pile and out-of-pile experiments designed to evaluate the effectiveness of internal helium pressurization of Zircaloy-clad UO_2 fuel rods are briefly described. Internal pressurization minimizes fuel-clad interaction, extends strain fatigue life under cyclic operation, and reduces fuel swelling and fuel temperatures. The technique is to be applied to all future PWR cores, to improve fuel reliability and operational capability. (UK)

43769 PLUTONIUM RECYCLING IN HEAVY-WATER-MODERATED THORIUM REACTOR SYSTEMS. Darvas, J.; Hansen, U.; Teuchert, E. (Kernforschungslange, Juelich, Ger.). Nucl. Appl. Technol.; 8: 496-506(Jun 1970).

The use of Pu as a makeup fuel in D_2O-moderated thorium-converters is investigated. The reactor starts with plutonium, the bred ^{233}U is reprocessed and fed back into the system. During reactor life there is a considerable change in fissile composition. The physics calculations follow the reactor through the whole running-in period from the first core into a "quasi-equilibrium" state. For this type of system, the running-in period makes an important contribution to the over-all merits of the reactor. The physics of the Pu-burner is compared in detail to a similar reactor using ^{235}U as make-up fuel. The evaluation of fuel cycle costs is performed with present worth methods, calculating "quasi-equilibrium" costs and average fuel cycle costs for the reactor lifetime, running-in period included. Thorium-systems starting and running with plutonium-makeup have to pay rather high penalties for the first refuelling periods. The Pu-value is estimated to be in the range of $9/g fissile. (auth)

Auxiliary and Emergency Systems

43770 (IN-1384) SEMISCALE BLOWDOWN AND EMERGENCY CORE COOLING (ECC) PROJECT. Haire, J. C.; Brockett, G. F. (Idaho Nuclear Corp., Idaho Falls). Jul 1970. Contract AT(10-1)-1230. 43p. Dep. CFSTI.

A description of the objectives, test program, and test equipment for the Semiscale Blowdown and Emergency Core Cooling (ECC) Project is presented. The project is to investigate the phenomena associated with the loss-of-coolant accident in a pressurized water reactor system. Experimental information that will aid in predictive code development and evaluation is to be obtained with a test system that is designed to model a large pressurized water reactor system. Blowdown tests have been performed with systems that consisted of a simulated vessel only, and the simulated vessel with an operating primary loop. Tests are to be performed with systems that will include core heat, emergency core coolant injection, and more than one operating primary loop. Test information will be obtained that is expected to aid in defining blowdown phenomena such as core fluid availability, system mass leak rate, and the interaction between the system coolant and the emergency core coolant. 12 references. (auth)

43771 (NP-9744) SOME EXPERIMENTS ON COMBINED DUST FILTER AND RESTRICTOR UNITS FOR THE DRAGON FUEL ELEMENT PURGE SYSTEM. Project DRAGON. Horsley, G. W.; Hosegood, S. B. (Atomic Energy Establishment, Winfrith (England)). Nov 1960. 28p. (DP-Report-8). Dep. CFSTI.

A restrictor unit for the Dragon fuel element purge flow to be

placed in series with each fuel element was developed. If the total purge flow is constant at a value of 5 liters/sec of helium at 350°C and 20 atm, and the normal pressure drop down a fuel element ≈4 psi, in the event of one fuel element being badly seated on its spike, the effect of the restrictors will be to maintain the purge flows through the other 36 fuel elements to within ~95% of their intended values. The restrictor is a $^5/_{64}$ inch orifice which is protected by a 2 inch cyclone from possible blockage by solid particles. At normal flow rates the cyclone should remove from the gas stream particles of carbon greater than ~15 μ in diameter. (auth)

43772 (WCAP-5352) ECCS VARIABLE FLOODING RATE SIMULATION PWR FLECHT TEST RESULTS. Cadek, F. F.; Dominicis, D. P.; Leyse, R. H.; Cermak, J. O. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). [1970]. Contract AT(10-1)-1230. 5p. Dep. CFSTI.

The results of tests simulating a typical core reflooding rate for a double ended cold leg break are presented. The effects of entrained liquid fallback on clad temperature response are discussed. (H.D.R.)

Operation and Economics

Refer also to abstracts 43709 and 43830.

43773 (AEEW-R-620) CALEB: A THREE-DIMENSIONAL FLUX SYNTHESIS CODE FOR FUEL MANAGEMENT STUDIES IN SGHWR'S. Robinson, G. S.; Fayers, F. J. (Atomic Energy Establishment, Winfrith (England)). Aug 1969. 52p. Dep. CFSTI (U. S. Sales Only).

The CALEB code embodies a special variant of flux synthesis which has been found successful for computing the three-dimensional complexities of fuel management schemes in SGHWRs. The synthesis involves separating the three-dimensional flux distribution into a slowly varying axial component coupled to a mean two-dimensional component in the x–y plane. This choice of synthesis is particularly effective for dealing with the power-dependent feedbacks associated with void, Doppler, and xenon distributions. The basic equations and numerical methods adopted in the flux and hydraulic solutions and the results of numerical tests of speed and accuracy are presented. Some special features of the code include the ability to study the use of variation of reactor flow to control reactivity or power distribution in reactors with a large void coefficient, such as the natural uranium SGHWR. Some illustrative results of CALEB calculations for a conceptual reactor system using flow control are included. (auth) (UK)

43774 (DP-Report-211) BURN-UP IN A LARGE HIGH-TEMPERATURE GAS COOLED REACTOR. Project DRAGON. Schloesser, J. (Atomic Energy Establishment, Winfrith (England)). Aug 1963. 16p. (CONF-178-12). Dep. CFSTI.

From European Atomic Energy Society's Symposium on Fuel Cycles for Power Reactors, Baden-Baden, Ger.

The burn-up curve for thorium–uranium systems in a large power reactor is developed, based on core compositions obtained from studies by the U.K.A.E.A. Two different loading procedures, complete core replacement and continuous charge-discharge have been studied, the actual loading procedure will be somewhere in between. Fuel costs can be reduced by about 30% by using continuous charge-discharge. The analysis shows that fifa values between 1.12 for complete core replacement and 1.98 for continuous charge-discharge can be reached for core compostions with a moderator ratio of S ≈ 3,400 and a fertile to fissile atomic ratio of N ≈ 9. Over a wide range of fabrication and separation costs core compositions with an S-value between 3,500 and 5,000 and an N-value between 10 and 15 are the most promising ones. 6 references. (auth)

43775 (DP-Report-393) DRAGON OPERATIONS FIRST QUARTERLY PROGRESS REPORT, JUNE TO AUGUST 1965. Project DRAGON. Barclay, F. J. (Atomic Energy Establishment, Winfrith (England)). Jan 1966. 29p. Dep. CFSTI.

The initial stages of the approach to power are described. The integrated power reached 20 MWD and the power level was 5 MW at the end of the period. The operation and maintenance of items of reactor and chemical plant equipment are dealt with under separate headings and details of core and primary circuit performance are given. The future program of operation is outlined. (auth)

43776 (DP-Report-418) FUEL CYCLES IN HIGH-TEMPERATURE REACTORS ON THE POWER DISTRIBUTION IN A FOUR-ZONE SYSTEM. Project DRAGON. Nyffenegger, U. (Atomic Energy Establishment, Winfrith (England)). Apr 1966. 38p. Dep. CFSTI.

Power distributions in a large ^{235}U/Th High Temperature Reactor are calculated, taking into account the radial variation of fuel depletion. A simple method is given to improve the power shape factors. (auth)

43777 (NP-10873) DESCRIPTION OF A ONE-DIMENSIONAL TWO-GROUP BURN-UP PROGRAMME FOR THE MERCURY COMPUTER. Project DRAGON. Schloesser, J. (Atomic Energy Establishment, Winfrith (England)). Sep 1961. 28p. (DP-Report-53). Dep. CFSTI.

The program calculates the radial dependence of the depletion and buildup of isotopes important for the ^{232}Th–^{233}U–^{235}U cycle in two energy groups for a cylindrical graphite moderated reactor. A detailed description of the various steps of the calculation is given. (auth)

43778 (UJV-2413-RT) METHOD OF DETERMINATION OF CANDU TYPE POWER STATION PARAMETERS AND ECONOMIC OPTIMIZATION. Jakab, J.; Kujal, B.; Kujal, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). [1969]. 77p. (In Czech). Dep. CFSTI (U. S. Sales Only).

The determination of the main parameters of a nuclear power station with CANDU type reactor is described. The thermophysical calculation including burnup and radial thermal flux flattening is introduced in detail. Calculation of the costs of electricity is presented. The general optimization method based on minimisation of the criterion function is described. (auth)

43779 PURCHASER'S POINT OF VIEW. Cave, L. Nucl. Eng. Int.; 15: 626-8(Jul-Aug 1970).

The main considerations for the intending purchaser of nuclear plant are considered and the need to secure high availability in order to obtain the maximum economy of operation is highlighted. (auth) (UK)

43780 OUTLOOK FOR WATER–WATER POWER REACTORS. Skvortsov, S. A. At. Energ. (USSR): 28: 294-7(Apr 1970). (In Russian).

Water–water reactors can attain on the average a specific power of 100 kW/l at a cost of 130 to 150 rubles/kW of installed capacity in the range of plants having a power of 500 to 1000 MW. These capital costs exceed those for large, coal-burning plants. Hence, to be competitive, atomic energy plants must lower their fuel costs which attain a minimum value of 0.2 to 0.3 cents/kWh with a fuel enriched about 3 to 5% in ^{235}U. In this case the total cost of electrical energy from atomic energy plants becomes competitive with the cost of electrical energy from coal-burning plants. Pressurized water-cooled and moderated reactors operate at an overall efficiency of 32 to 34%. The thermal water-cooled and moderated reactors suffer from the disadvantage of a low breeding efficiency, but they should undergo rapid development and use in industrial practice until fast neutron breeders are developed to take their place. The U–Th cycle can also be used as an intermediate step in the full use of nuclear resources. (TTT)

43781 FUEL ELEMENT EXCHANGE IN POWER REACTORS. Paulicka, Ivan (Bohunice Atomic Power Plant, Jaslovske Bohunice, Czech.). Jad. Energ.; 16: 217-20(Jul 1970). (In Czech).

Assuming that a certain region of a power reactor is in a stationary state of operation characterized by an equilibrium charge of fuel elements, general relations valid between the given radiation stability of the fuel elements and the number of elements in the given region are derived, taking into account the given excess reactivity and variation of the multiplication coefficient. It is proved that the required radiation stability increases with the number of fuel elements in the region. For transition to the equilibirum charging of fuel elements from the initial state in the region with fresh elements, the basic equation of the transition process is shown, and its solution with various boundary conditions gives rise to various systems of charging. Results for more important systems are tabulated. From the results it follows that the characteristics of the transition states are dependent upon the number of elements in the region. (auth)

43782 ECONOMICS OF BLENDING AND DIFFUSION IN URANIUM RECYCLE. MacCragh, A. (Washington Research Center, Clarksville, Md.). Nucl. Appl. Technol.; 8: 437-44 (May 1970).

An equation is derived to compare the costs of two schemes for recycling spent fuel to light water reactors: diffusion and blending. The calculations show that blending is slightly more costly than diffusion. The factors that can chiefly influence this conclusion are the discharge enrichment and the value of ^{236}U. A very high burnup would favor diffusion; a very high price for ^{238}Pu and, therefore, for ^{236}U, would render blending the desirable route. (auth)

Safety and Siting

Refer also to abstracts 41242, 41654, and 43770.

43783 (BMI-1885) AN EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Quarterly Progress Report for April–June 1970. Carbiener, Wayne A.; Ritzman, Robert L. (Battelle Memorial Inst., Columbus, Ohio). Jul 1970. Contract W-7405-eng-92. 52p. Dep. CFSTI.

CONTAINMENT SYSTEMS EXPERIMENT — iodine removal in, effects of spray solution redox potential on, (E/T)
FISSION PRODUCTS — removal from reactor containment, effectiveness of sprays and pressure suppression pools for, (E/T)
IODINE — removal from reactor containment vessels, effectiveness of aqueous sprays for, (E/T)
REACTOR CONTAINMENT SYSTEMS — fission product entrainment by pressure suppression pools in, (T)
REACTOR SAFETY — coolant loss accidents in water cooled reactors, analytical description of
— analysis of reactor accidents, mathematical and graphical
REACTORS, BOILING — emergency core cooling system in, effects on prompt fission product release of failure of, (T)
— cooling channel blockage in, effects on cladding temperatures of, (T)
— coolant loss accidents in, analytical description of
REACTORS, PRESSURIZED WATER — control rod ejection accidents in, kinetics of, (T)
— coolant loss accidents in, effects of delayed emergency coolant injection on heat transfer following, (T)
— coolant flow coastdown incidents in, effects on cladding temperatures of, (T)
— coolant loss accidents in, analytical description of
REACTORS, WATER COOLED — coolant loss accidents in, ECCSA and MUCHA codes for thermal–hydraulic analysis of (H.D.R.)

43784 (CONF-700608-13) SCALBATRAIO CENTER FOR RESEARCH IN NUCLEAR SAFETY. Guerrini, B.; Lanza, S.; Mazzini, M.; Mirandola, R. (Pisa Univ. (Italy). Istituto di Impianti Nucleari). [1969]. 43p. Dep. CFSTI (U. S. Sales Only).

From American Nuclear Society Meeting, Los Angeles, Calif.

Scalbatraio Centre, which has been set up by the Nuclear Engineering Institute of the University of Pisa for research in nuclear safety, is briefly described. Research programs and the main experimental facilities are indicated. Most of the work is concerned with the effectiveness of sprays as engineered safety feature for water reactors. PSICO 10 equipment for spray tests is described in summary; this equipment includes a model containment vessel of 100 m^3. Principal results of the work on iodine removal by sprays are also reported. (auth)

43785 (DOCKET-50231-52) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Malfunction of the Emergency Electrical System Tie Breakers. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 5 Aug 1970. 3p. Dep. CFSTI.

43786 (EURFNR-738) THE BEHAVIOR OF UO_2 AEROSOLS IN CLOSED SYSTEMS. Schikarski, W.; Wild, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Translation of report KFK-1032. 71p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The behavior of aerosols which can be formed during large accidents of fast nuclear reactors is investigated. The program is aimed at the development and at experimental verification of the aerosol model which describes activity release via the transport characteristics of nuclear aerosols. The behavior of UO_2 aerosols in an inert atmosphere was investigated. The UO_2 aerosols were created by the exploding wire technique in two different stainless steel vessels of 2.2 m^3 and 0.02 m^3 volume. The decrease of the particle number concentration and of the mass concentration with time was measured for various time intervals up to one week. The measured initial particle number concentrations of about 10^7 particles/cm^3 decreased several decades whereas the measured initial mass concentration decreased one decade during the experiments. The shape of the time functions of particle number concentrations allows separation into three ranges. The primary range can be attributed to the coagulation process, the final range can be attributed to the sedimentation process. An analytical expression was developed which gives by means of an empirical term good agreement between experiment and theory. This correlation gives the possibility, in the range of experimental errors and with the condition that extrapolation to larger volumes is allowed, of estimating the decrease of aerosol concentrations in nuclear reactor buildings as function of time. 10 references. (auth)

43787 (EURFNR-754) SODIUM-AIR REACTION AS A REACTOR FAULT CONDITION. Keller, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Translation of report KFK-1034. 47p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Temperature and pressure curves are derived for Na–air reactions as a function of the type of Na fire. Conclusions are drawn with respect to the stress on the containment. The reaction rates are studied for the various relevant chemical reactions as a function of the reactor fault and the type of Na fire. 4 references. (auth)

43788 (IN-1321) RELAP3: A COMPUTER PROGRAM FOR REACTOR BLOWDOWN ANALYSIS. Rettig, W. H.; Jayne, G. A.; Moore, K. V.; Slater, C. E.; Uptmor, M. L. (Idaho Nuclear Corp., Idaho Falls). Jun 1970. Contract AT(10-1)-1230. 123p. Dep. CFSTI.

RELAP3 is a computer program, written in FORTRAN IV, that describes the behavior of water-cooled nuclear reactors during postulated accidents such as loss-of-coolant, pump failure, or power transients. The behavior of the primary cooling system and the reactor is emphasized. The program calculates flows, mass inventories, energy inventories, pressures, temperatures, and qualities along with variables associated with reactor power, reactor heat transfer, or control systems. The program is sufficiently versatile to describe simple hydraulic systems as well as complex reactor systems. The user must define the geometric description of the system to be analyzed as well as an appropriate set of initial conditions. RELAP3 then solves an integral form of the fluid conservation and state equations applied to each user-defined control volume. Currently, the number of these volumes is limited to 20 and the number of junctions (flow paths) between volumes to 50. By simply increasing the array sizes these limits could be raised until the capacity of the particular computer is reached. RELAP3 source decks are available in single (BCD) and double precision (EBCDIC) versions. Use of special timing and input-output routines (available for the IBM 7044 and the IBM 360 systems) is desirable, but not necessary. Sample problems have been run on a wide variety of computers: IBM 7044, Univac 1108, CDC 6600, and IBM 360/75. The most recent changes have only been tested on the IBM 360/75 computer. (auth)

43789 (IN-1412) A CORRELATION OF ROD BUNDLE CRITICAL HEAT FLUX FOR WATER IN THE PRESSURE RANGE 150 TO 725 PSIA. Hughes, E. Daniel (Idaho Nuclear Corp., Idaho Falls). Jul 1970. Contract AT(10-1)-1230. 75p. Dep. CFSTI.

Rod bundle critical heat flux data for water in the pressure range 150 to 725 psia have been compiled and several correlations derived. The analysis has been conducted only for steady state data obtained from uniform axial flux profile rods with stable upflow of the coolant. The selected correlation, that is, the best fit of the data, was compared with data outside of the range of parameters on which it was based and no definite error trends were noted. An analysis of the methods of correlation in current use is presented and the most accurate correlations are shown to be those that incorporate observed experimental results into the formulation of the correlation. 56 references. (auth)

43790 (JAERI-1188) A STUDY OF DESTRUCTIVE ENERGY RELEASED AT FAST BREEDER REACTOR MAXIMUM HYPOTHETICAL ACCIDENT. Ishikawa, Michio; Hirakawa, Naohiro; Tasaka, Kanji (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Jul 1970. 20p. Dep. CFSTI (U. S. Sales Only).

A computing model to calculate destructive energy release at maximum hypothetical accident is developed. Two types of energy release, pressure wave propagation and vapor blast pressure, are considered as realistic destructive energy release. In the computing model, acoustic impedance effect resulting from the molten core expansion is assumed for the pressure wave propagation and results of past reactor destructive tests are utilized in the vapor blast pressure calculation. The calculations were carried out on the hypothetical accident of JEFR (Japan Experimental Fast Reator) and it is found that 8 MWs of energy would be released by pressure wave propagation with 960 kg/cm^2 of peak pressure and that 98 MWs of energy would be released by vapor blast pressure with 21 kg/cm^2 of equilibrium pressure. These results make good correspondence with the $\frac{1}{8}$ scaled mock up vessel explosive test performed with 400 g TNT powder in JAERI, 1968. Therefore, this

model seems to give more realistic estimation of destructive energy released at the maximum hypothetical accident of a fast breeder reactor than those models generally used. 36 references. (auth)

43791 (NP-10130) SOME ASPECTS OF THE CONSTRUCTION AND SITING OF GAS-COOLED REACTORS. Project DRAGON. Steudler, C. (Atomic Energy Establishment, Winfrith (England)). Mar 1961. 43p. (DP-Report-26). Dep. CFSTI.

Some of the problems which face the civil engineer and the contractor are investigated for the gas-cooled reactors developed in Great Britain. Most of the considerations are relative to the magnox reactors. Some of the differences between conventional and nuclear power stations using gas-cooled reactors are also outlined. Consideration is given to underground schemes which seem to be fairly attractive in the case of nuclear power stations because of the safety requirements. (auth)

43792 (ORNL-TM-2999) QUALITY-ASSURANCE PRACTICES IN CONSTRUCTION AND MAINTENANCE OF THE MOLTEN-SALT REACTOR EXPERIMENT. Webster, B. H. (Oak Ridge National Lab., Tenn.). Apr 1970. 106p. Dep. CFSTI.

The MSRE was built at Oak Ridge National Laboratory to demonstrate the practicality of the molten-salt reactor concept. Site construction and installation of auxiliary systems were by outside contractors, while the primary reactor systems were installed by ORNL forces. Design, procurement, construction, and maintenance followed ASME codes, ORNL practices, and special procedures developed for the MSRE by the ORNL Reactor Division group primarily responsible for quality assurance. The quality assurance program, the problems that were encountered, and the lessons that were learned are presented. Four years of reliable operation of the MSRE proved the success of the quality-assurance program. (auth)

43793 (ORNL-TM-3078) OPERATION OF A SPECIALIZED SCIENTIFIC INFORMATION AND DATA ANALYSIS CENTER WITH COMPUTER BASE AND ASSOCIATED COMMUNICATIONS NETWORK. Cottrell, Wm. B.; Buchanan, J. R.; Cardwell, D. W. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 53p. Dep. CFSTI.

The Nuclear Safety Information Center is a highly sophisticated scientific information center operated at ORNL for the U. S. Atomic Energy Commission. Its information file, which consists of both data and bibliographic information, is computer stored and numerous programs have been developed to facilitate the use of this information by its diverse users through the many services which the Center performs. In support of its work the Center maintains part of a small communications network which now includes 13 remote terminals (6 in NSIC offices) through which most information is added to the computer and much is routinely retrieved. The supporting programming permits extensive manipulation of the computer stored information as well as interactive telecommunications from all of the remote terminals. The Center is staffed by selected senior laboratory technical personnel who are assigned on a part time (avg ~1/3) to the Center. Recommendations for the development of an information system for the Coast Guard include an interim system for immediate use prior to the development of the ultimate system. The former would include installation of a teletype unit at NSIC to connect to an existing Coast Guard system through which unit, and a manual link, information could be retrieved from a computer store developed at ORNL. The ultimate system would involve transfer of the computer store to the CDC to be installed at Coast Guard Headquarters and a network of remote consoles including one at NSIC for the maintenance of the store. (16 references) (auth)

43794 (WCAP-5353) EFFECT OF 75 PERCENT TO 100 PERCENT FLOW BLOCKAGE ON BOTTOM COOLING HEAT TRANSFER EFFECTIVENESS. Dominicis, D. P.; Cadek, F. F.; Leyse, R. H.; Cermak, J. O. (Westinghouse Electric Corp., Pittsburgh, Pa.). [1970]. 5p. Dep. CFSTI.

Two series of flow blockage tests were performed in the PWR-FLECHT program to determine the effect of flow blockage on heat transfer in bottom flooding. The tests in which blockage was varied from a uniform 75% blockage of the flow area of a 10 × 10 rod bundle to 100% blockage of 16 flow channels with the rest of the bundle blocked 75% to 90% are described. The test section consisted of 91 heated rods and 9 non-heated tubes 12 ft in length, which simulated the fuel rods and control rod thimbles in a section of a PWR fuel assembly. The heat generation in the rods was distributed in an axial cosine shape of 1.66 peak to average with simulation of decay heating. The rods were stainless steel clad with internal heating elements of Kanthal, with boron nitride insulation between the clad and heater element. Results of the tests are presented. (3 references) (auth)

43795 HYDRODYNAMIC RESPONSE OF PRIMARY REACTOR CONTAINMENT TO HIGH-ENERGY EXCURSIONS. Chang, Y. W.; Gvildys, J.; Fistedis, S. H. (Argonne National Lab., Ill.). Nucl. Eng. Design; 12: 344-60(1970).

A numerical method for calculating the two-dimensional hydrodynamic response of a primary reactor containment system to a high-energy excursion is described. Equations of hydrodynamics and equations of state of reactor materials are expressed in Lagrangian form and then set into finite-difference equations. Shock discontinuities are eliminated by the use of the Von Neumann-Richtmyer pseudo-viscosity q. These equations, along with pressure pulse and other pertinent input data, are programmed for solution on the IBM-360 computer. Propagation of shock waves, loads imposed on different parts of the reactor components, and the resulting damage are determined at every time step until the steel vessel ruptures or the force acting on the rotating shield plug exceeds the strength of the plug hold-down device. Calculated displacements and pressures at all spatial points at any instant of time also can be given in pictorial form. (10 references) (auth)

43796 INELASTIC RESPONSE OF PRIMARY REACTOR CONTAINMENT TO HIGH-ENERGY EXCURSIONS. Cinelli, G.; Gvildys, J.; Fistedis, S. H. (Argonne National Lab., Ill.). Nucl. Eng. Design; 12: 361-80(1970).

The inelastic response of primary containment to a high-energy axisymmetric excursion is found by numerical techniques. First, the equation of state of inelastic behavior is discussed. Then the basic conservation laws of mass, momentum, and energy are given in Eulerian coordinates. These equations are then transformed into Lagrangian coordinates and the finite difference equations for numerical computation. Finally, the results of a sample problem calculation are given. (auth)

43797 TREAT SODIUM LOOP EXPERIMENTS ON PERFORMANCE OF UNBOUNDED, UNIRRADIATED EBR-II MARK I FUEL ELEMENTS. Dickerman, C. E.; Willis, F. L.; Smith, R. R.; (and others) (Argonne National Lab., Ill.). Nucl. Eng. Design: 12: 381-90(1970).

Sodium loop experiments were performed in the Transient Reactor Test (TREAT) Facility specifically to provide guidance for analyses on the behavior of an element which either has no sodium thermal bond between fuel and cladding or which, due to some unspecified defect, loses the bond upon reactor startup. Transient heat transfer calculations of the experiments were performed utilizing an idealized model of meltdown in which fuel slumping against the cladding was assumed to occur instantaneously along the length of the pin when the fuel surface at the axial midplane reached 1050°C. The results of TREAT experiments and of the calculations imply that although fuel melting may accompany a loss-of-bond type failure in an EBR-II driver fuel element, the short term consequences are acceptable from the viewpoint of reactor safety. Comparison of results from calculations and experiment indicates that the relatively simple modelling used represents a conservative description of the temperature rise in the cladding following fuel-cladding contact resulting from the fuel melting. (13 references) (auth)

43798 POWER PULSE MELTDOWN EXPERIMENTS PERFORMED IN THE MARK I TREAT SODIUM LOOP ON CLUSTERS OF 7 EBR-II MARK I TYPE PINS. Dickerman, C. E.; Robinson, L. E.; Purviance, R.; DeVolpi, A.; Willis, F. L.; Cohen, A. B.; Regis, J. (Argonne National Lab., Ill.). Nucl. Eng. Design; 12: 391-406(1970).

Two experiments were performed on fuel failure and post-failure movements of fuel and coolant under power excursions. Test samples consisted of seven-pin clusters in instrumented integral sodium loops inserted into the TREAT reactor. One cluster was run with sodium flow and the other with pump power off (transient-induced flow could occur). Results agreed with the predictions of a simple calculational model of pin failure which had been tested previously in less elaborate experiments. Extensive post-failure movements of molten fuel occurred. Although sharp pressure spikes were recorded their magnitude is within a range that can be accommodated by reasonable engineering designs. (29 references) (auth)

Power Conversion Systems

43799 LARGE CAPACITY HYDROSTATIC GAS BEARINGS APPLIED TO THE TURBO-MACHINES OF A DIRECT NUCLEAR HELIUM CYCLE. Mech, C.; Poulain, J. (Societe Rateau, La Courneuve, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 82, 9-16(Mar-Apr 1970). (In French).

In the very general context of large capacity hydrostatic gas bearing development, an experiment is planned to take place in the near future on a 10,000 kg rotor. The possibility is examined of building the free-running turbo-machines of a direct nuclear helium cycle on this basis. The study shows that the capacity of 10,000 kg considered enables the use of gas bearing machines to be envisaged now for high power direct cycles. A 600 MW(e) helium cycle is given as an example. After having defined the organization of turbo-machines, the advantages derived from using gas bearings are discussed. To conclude, information is provided on the technology of large capacity hydrostatic bearings and the research programmes in hand. (auth) (France)

43800 CHOICE OF THE ROTATION SPEED OF LARGE NUCLEAR TURBINES FROM AN UTILIZATION POINT OF VIEW AND FOR 50HZ NETWORKS. Brun, J.; Tessier, J. (Electricite de France, Paris). Energ. Nucl. (Paris); 12: 230-8(May-Jun 1970). (In French).

The technical and economical aspects of the choice of the rotation speed of large nuclear turbines are analyzed. The results obtained with 1500 rpm and 3000 rpm turbines are compared. Electricite de France seems to prefer 1500 rpm turbines for large nuclear units. (auth) (France)

Research and Test Reactors

Refer also to abstracts 41569, 41580, 41605, 41715, 42061, 42087, 42088, 42176, 42280, 43634, 43682, 43686, 43689, 43754, and 43857.

43801 (AE-399) ANALYSIS OF PULSED SOURCE EXPERIMENTS PERFORMED IN COPPER-REFLECTED FAST ASSEMBLIES. Kockum, Joergen (Aktiebolaget Atomenergi, Studsvik (Sweden)). Jun 1970. 31p. Dep. CFSTI (U. S. Sales Only).

Pulsed source experiments performed in two copper-reflected fast assemblies have been analysed with a time-dependent S_N code. It has been shown that no spectral equilibrium will be reached within the reflector due to the long slowing-down time in copper. A situation with a core and a reflector centered neutron population will develop but the interaction parameters will not be time-independent, making a two-region model only qualitatively valid. If the decay time of the core is longer than that of the reflector—which is shown to be the case for a soft spectrum core close to critical—it is shown to be approximately possible to use the point reactor model to determine a neutron lifetime. A better meeting ground for experiment and calculations is, however, a direct calculation of the decay constant, which in this case was calculated to within 5% of the experimental value. The difference indicates a somewhat too soft calculated spectrum. The area method has been used to determine the reactivity in one of the assemblies. It gives reactivity values which agree rather well with values determined by other methods close to criticality but which show an increasing discrepancy for more subcritical systems. (15 references) (auth)

43802 (ANL/EBR-23) PRELIMINARY SYSTEM DESIGN DESCRIPTION OF THE EBR-II IN-CORE INSTRUMENT TEST FACILITY. EBR-II Project. Hutter, E.; Seim, O. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Jun 1970. Contract W-31-109-eng-38. 58p. Dep. CFSTI.

The EBR-II In-core Instrument Test Facility (INCOT) provides the means of inserting instrument sensors into the EBR-II core, exposing them to a fast-neutron flux of 2×10^{15} nv, and monitoring their performance during their experimental life. The facility includes a thimble assembly that serves as a container for one of three basic types of sensor assemblies, which hold the test sensors during irradiation. The thimble assembly extends from the core, up through the reactor-vessel cover, into the primary-tank sodium, and from there through the small rotating shield plug and onto the operating floor. There it is connected, through a terminal box, to the elevating system that provides the necessary motions to make the facility compatible with reactor fuel-handling operations. Shielded handling containers make it possible to remove individual tests or experiments from the facility and to remove parts of the facility itself. A system for transmitting sensor data carries the sensor signals to the instrument readout and data-logging equipment. The facility, the principles of operation, and pertinent safety precautions are described. (auth)

43803 (ANL/EBR-24) PRELIMINARY SYSTEM DESIGN DESCRIPTION OF THE EBR-II FAILED-FUEL TRANSFER SYSTEM. EBR-II Project. Divona, C. J.; Hutter, E. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Jul 1970. Contract W-31-109-eng-38. 27p. Dep. CFSTI.

The failed-fuel transfer system provides additional capability to remove subassemblies, which contain failed fuel, from the primary tank in the reactor building to the argon cell of the Fuel Cycle Facility (FCF). The major parts of the system are: a dipper, with associated components; and a sealed container, with a radiation shield. The dipper retrieves the subassembly from the transfer arm and acts as a temporary storage facility by keeping the subassembly inside the primary tank without impeding standard fuel-handling operations. The dipper, containing the subassembly and sodium, can be lifted through the "X"-nozzle plug into the sealed container. The sealed container is surrounded by a radiation shield in such a manner that the combined assembly can be transferred through the equipment air lock and the reactor passageway to the basement below the FCF air cell. The radiation shield is left in the basement and the sealed container is lifted through the floor hatch of the air cell into the air cell and from there into the argon cell of the FCF. 3 references. (auth)

43804 (BAW-1357) PLUTONIUM LATTICE EXPERIMENT IN UNIFORM TEST LATTICE OF $UO_2 - 1.5\%$ PuO_2 FUEL. Fairburn, G. T.; Pettus, W. G.; Snidow, N. L. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Aug 1970. Contract AT(45-1)-1830. 38p. Dep. CFSTI.

The plutonium lattice experiments are conducted to provide data for verification of the analytical methods and models developed for the design of water-moderated plutonium recycle cores. Because of the great expense of performing conventional critical experiments with a variety of fuels, the program is restricted to "small lattice experiments" (SLE), which are essentially PCTR measurements that require a relatively small region of the test fuel surrounded by buffer and driver regions of conventional fuel. The system is tailored to provide a critical assembly with a small central test region having a nearly flat flux and asymptotic spectrum. The test region is incrementally poisoned with boric acid until a void substitution yields a null reactivity change. This gives a precise measure of the boron concentration required to reduce to unity the infinite medium multiplication factor of the test lattice. Comparison of this number with the corresponding analytical prediction is a sensitive and direct check on the adequacy of the theoretical procedures. Various other measurements are also taken on the poisoned and unpoisoned test lattice for other tests of the analytical methods and to facilitate the deduction of k_∞ for the unpoisoned lattice. The facility, the equipment, the techniques of measurement, and the results of the measurements are presented. (3 references.) (auth)

43805 (BNWL-1064) FFTF FUEL PIN AND SUBASSEMBLY CONCEPTUAL DESIGN METHODS AND DATA. Stevens, E. G.; Cohn, P. D.; Jackson, R. J.; Kolesar, D. C.; Mohr, C. L.; Padilla, A.; Wheeler, C. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 186p. Dep. CFSTI.

The major technical bases for the FFTF first core fuel assembly conceptual design are presented in four general categories: thermal; hydraulic; structural; and performance-manufacturing design characteristics. Recommended design values and conceptual engineering drawings of the fuel pin and subassembly are included. (102 references.) (auth)

43806 (BNWL-1251) FFTF CLOSED LOOP TEST CHARACTERISTICS. Keyes, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 58p. Dep. CFSTI.

A set of curves which characterize the FFTF closed loop testing capability are presented. Limiting parameters for candidate breeder-reactor fuels are discussed. Heat removal requirements of the ex-reactor loop system are set by the maximum of a variety of possible test designs. The study concludes that a 2 MW heat removal capacity is adequate for a maximum test diameter of 2.5 in. (8 references.) (auth)

43807 (BNWL-1409) THERMAL AND HYDRAULIC ANALYSIS OF A PHOENIX FUEL IN THE MATERIALS TEST REACTOR. Hiatt, R. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 93p. Dep. CFSTI.

A Phoenix fuel loading of the Materials Test Reactor at Idaho was investigated to determine safe operating power levels based on thermal and hydraulic considerations. Design points are clearly stated with emphasis placed on flow problems and heat transfer burnout limits. 13 references. (auth)

43808 (BNWL-SA-2818) INTERMEDIATE HEAT EXCHANGER MODELING FOR FFTF SIMULATION. Gunby, A. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 15 Sep 1969. Contract AT(45-1)-1830. 29p. (CONF-690959-1). Dep. CFSTI.

From Meeting on Techniques in Simulation, Richland, Wash.

The intermediate heat exchanger (IHX) is an extremely important part of the FFTF heat transport system, as the response characteristics of the IHX are felt directly by both reactor and dump heat exchanger (DHX). For hybrid system simulation, an IHX model is needed which will perform well for a wide range of conditions, including severe temperature ramps, flow coastdowns, and unbalanced flows. Such a model may be a "black box" approach, with primary and secondary outlet temperatures responding appropriately to flow and inlet temperature changes, and internal parameters. The results of comparing several IHX models using, the DYNASAR program are presented. IHX models are described, models are compared for a wide spectrum of flow and temperature transients, and conclusions are drawn as to the best model for FFTF hybrid simulation. (auth)

43809 (CEA-N-1317) IRRADIATION DEVICE ODILE. Fages, Denis; Lauthier, Jean-Claude; Leclere, Jacques; Lhermenier, Andre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1970. 51p. (In French). Dep. CFSTI (U. S. Sales Only).

For experimental irradiations of fast reactor project fuels, a device to be used in pool type reactors, Osiris or Siloé, was designed and fabricated. Its main features are: static sodium cooling, the sodium being always kept liquid by electrical heaters; temperature adjustment by variable thermal barrier; flux adjustment by moving towards reactor core; and the ability to take neutrographies. Capable of evacuating more than 800 W/cm for small elements, the device Odile meets most of the requirements for fast reactor project irradiations. (auth) (France)

43810 (CEA-R-3984) REACTOR OSIRIS: DESCRIPTIVE REPORT. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr 1970. 232p. (In French). Dep. CFSTI (U. S. Sales Only).

OSIRIS is a swimming pool reactor of 70 MW thermal power. Its main purpose is irradiation of nuclear power station structural materials in high neutron flux. The general characteristics of the installation result from a technical choice for having in OSIRIS a reactor where there can be many irradiations in high flux. The installations which must not be changed (place, irradiation facilities, water circuits, control) and the core (fuel elements, neutron physics and thermal study) are described. For such a reactor, which must have a life of more than 10 years, it is possible to adapt to new programs. Details are given on the mode of functioning and the reactor operation after two years. (auth)

43811 (COO-385-3) EDUCATIONAL AND RESEARCH ACTIVITIES JANUARY 1, 1969-DECEMBER 31, 1969. (Michigan Univ., Ann Arbor. Michigan Memorial Phoenix Project). May 1970. Contract AT(11-1)-385. 22p. Dep. CFSTI.

During 1969, the Ford Nuclear Reactor (FNR) at The University of Michigan continued to serve as an integral part of the educational and research activities of the University. It also served other schools, hospitals, and industrial research organizations. By maintaining the continuous operating schedule of the reactor for the majority of the year and by improving laboratory and reactor irradiation facilities, the amount and types of services available to facility users were extended. Operations during 1969 are reviewed. (auth)

43812 (DP-Report-258) REMOVAL OF FISSION PRODUCT NOBLE GASES FROM THE HELIUM OF A HIGH TEMPERATURE GAS COOLED REACTOR USING CHARCOAL AT LOW TEMPERATURES. Project DRAGON. de Bruijn, H.; Gruetter, A.; Roemberg, E.; Wood, F. C. (Atomic Energy Establishment, Winfrith (England)). Jan 1964. 94p. Dep. CFSTI.

After the technical problem is outlined the initial results obtained from a study on the removal of fission product noble gases from helium by low temperature adsorption technique are reported. The results of break-through experiments on laboratory and technical scale are reported, after a description of the techniques and equipment used. Adsorption equilibrium and rate data at the temperatures of interest are presented. It is shown that not only "dynamic" and "static" equilibrium data are in good agreement with each other, but that they fit into the Dubinin extension of Polanyi's thermodynamic considerations. As a result it will be possible to use a "characteristic curve" of a particular adsorbent for predicting adsorption equilibrium data for other gases and other temperatures. A conclusive interpretation of the adsorption rate data for xenon on charcoal is not yet possible. Rate determining seems to be surface migration (solid phase diffusion). There are strong indications that at low temperatures the rate equation with a linear driving force relationship gives the best fit. The various break-through curves obtained are analyzed, making use of the equilibrium data and adsorption rate data obtained. It is concluded that the adsorbers of the plant constructed for the Dragon Reactor Experiment will amply meet their specifications. (23 references) (auth)

43813 (DP-Report-388) POST IRRADIATION RADIOCHEMICAL ANALYSIS OF CHARGE 8 FOR PLUTO LOOP A. Project DRAGON. Brown, P. E.; de Nordwall, H. J. (Atomic Energy Research Establishment, Harwell (England)). Oct 1965. 51p. (AERE-R-5040). Dep. CFSTI.

Charge 8 fuel was directly cooled by fast flowing helium without the intervention of a fuel tube and without a purge to remove gaseous fission products. During some six months of operation with a maximum fuel temperature of 1400°C only small fractions of important fission products entered the coolant. The distribution of these fission products in the coolant circuit and the fuel element parts is described in detail. 15 references. (auth)

43814 (EUR-4486) INVESTIGATION ON REACTIVITY VALUES OF Pu-U ROD CLUSTERS BY AN OSCILLATION METHOD. Boeuf, A.; Macke, E.; Tassan, S. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 31 Mar 1970. 176p. Dep. CFSTI (U. S. Sales Only). EUR FF 25.-.

The reactivity worths of synthetic Pu-U clustered fuel elements, in a D_2O moderated assembly, have been experimentally determined using the reactor oscillation method. Five different test-fuel compositions have been investigated, representing varying degrees of fuel burn-up and burn-up distributions; two U samples with different ^{235}U enrichment have been used as standard. The technique selected was aimed to establish "clean" experimental conditions, so as to effectively simplify the analysis of the results. Basically, it consisted in oscillating, according to a square-wave pattern, a 6 m long fuel element containing a 50 cm high test section with the investigated fuel composition: the corresponding neutron density modulation was interpreted in terms of a Fourier analysis. The results of the experiment form a consistent set of data, which can be used as test values for refined reactor burn-up calculation codes. The overall experimental error, typically ±0.015 pcm, is considered remarkably low, in view of the massive and complex experimental set-up used. A detailed description of the experimental work is presented. The error analysis, which is based on the results of an extensive series of tests, puts in evidence the flexibility of the experimental technique, in view of its use under more severe conditions for the determination of minor differential reactivity effects (as temperature coefficient of Pu vs. U fuel, etc.). (8 references) (auth)

43815 (GEAP-10010-24) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Twenty-Fourth Quarterly Report, February-April 1970. Pflasterer, G. R.; Becker, R. A. (comp.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). May 1970. Contract AT(04-3)-540. 70p. Dep. CFSTI.

SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR—fuel assemblies for, fabrication of instrumented
—startup testing of plutonium oxide (PuO_2)-uranium oxide (UO_2) fueled, (E/T)
—reflectors for, reactivity worth calibrations on, (E)
—core materials for, reactivity worth of, (E/T)
—reactivity worth measurements in, (E/T)
—operation during February to April 1970
—maintenance during February to April 1970
—thermocouples in, maintenance requirements for reflector (D.C.C.)

43816 (INR-1170) TEMPERATURE MEASUREMENTS OF THE EK-10 TYPE REACTOR FUEL RODS IN EWA-4 CORE. Aleksandrowicz, J.; Czerniewski, M.; Labno, L. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 48p. Dep. CFSTI (U. S. Sales Only).

The measurement programme of temperature of the EK-10 type of reactor fuel rods in steady and transient states of heat transfer conditions has been performed with EWA-2 and EWA-4 cores. Results of measurements performed with EWA-2 core were reported previously. The measurement results obtained in experiments performed with EWA-4 core are presented. The EWA-4 core consisted of fuel assemblies equipped with variable cross-section tubes inside of which the fuel rods had been placed. Two instrumented fuel rods were applied for measurements: one equipped with 5 surface thermocouples installed in the fuel cladding, and the second equipped with thermocouple for fuel rod core temperature measurement. In steady state, the EK-10 fuel temperature was measured for different cooling conditions and different reactor power levels. Transient tests were initiated by cooling water flow stopping and by ramp reactivity addition into the core. (auth)

43817 (TKK-F-A-106) RESONANCE INTEGRAL OF NATURAL ZIRCONIUM. Saastamoinen, Jaakko (Technical Univ. of Helsinki, Otaniemi (Finland). Dept. of Technical Physics). 1970. 6p. Dep. CFSTI (U. S. Sales Only).

The resonance integral of natural Zr was calculated for Zr rods of varying diameter and for the Triga fuel elements using different resonance parameters. The results are compared with values from other calculations and from experiments. 11 references. (auth) (Finland)

43818 CONVERSION OF A HORIZONTAL THERMAL COLUMN INTO A USEFUL NEUTRON SOURCE PLANE. Anglero, O.; Wethington, J. A. (Puerto Rico Nuclear Centre, Mayaguez). J. Nucl. Energy; 24: 221-5(Jul 1970).

The arrangement is described of a boral-lined void created by graphite removal, inside the thermal column of a 1 MW AMF pool type reactor, in order to obtain an axially symmetrical neutron flux at the vertical access position. Flux measurements showed that fast neutron leakage would not be large enough to cause serious problems in reactor physics experiments. The technique also increased thermal neutron flux at the vertical access position by a factor of approx 15. (UK)

43819 PNEUMATIC TRANSPORT OF RADIOISOTOPES IN THE VVR-S REACTOR. Kavan, Karel; Gaizl, Vaclav (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ.; 16: 96-8(1970). (In Czech).

A brief description of pneumatic transport equipment applied for the needs of activation analysis in the VVR-S reactor is given. (auth)

43820 NUCLEAR REACTOR OF THE POLYTECHNICAL INSTITUTE AT BUDAPEST. Chom, D. At. Energ. (USSR); 28: 342-6(Apr 1970). (In Russian).

The construction of this reactor which is intended primarily for teaching purposes will be finished in June or July of 1970. The fuel rods are of Soviet origin (EK-10), and contain 10% U-235. The moderator and heat transfer medium is water. The reflector is graphite plus water. The maximum reactivity is 0.5 to 0.6%, and the maximum power is 10 kilowatts with a thermal neutron flux of 10^{11} and a fast neutron flux of 7×10^{11} neutrons/cm^2-sec. The shielding material is water on top (5 m) and concrete on the side (110 cm of heavy concrete with a density of 3.2 g/cm^2 and 90 cm of ordinary concrete). The research equipment includes 5 horizontal irradiation channels, 1 irradiation "tunnel," 14 vertical channels, and 3 pneumatic tubes which are used for activation analyses. The graphite reflector is placed around the active zone. Courses in reactor physics, reactor technology, nuclear electronics, isotope technique, radiation protection, and dosimetry are given. Each course provides for 8 to 12 experiments on the reactor. (TTT)

43821 ATOMIC RESEARCH CENTER AT THE BIRTHPLACE OF V. I. LENIN. Kazachkovskii, O. D.; Krasnoyarov, N. V.; Ostreikovskii, E. P.; Petros'yants, A. M. At. Energ. (USSR); 28: 287-90(Apr 1970). (In Russian).

This center deals with the development of new types of atomic energy reactors. The BOR-60, fast neutron reactor with a sodium coolant has a power of 60 megawatts (thermal) and 12 megawatts (electrical). Physics parameters and experimental facilities are described. The behavior of materials under irradiation is also investigated in the SM-2 and MIR reactors. The MIR reactor tests full-scale prototypes of fuel elements, and the SM-2 reactor is used mainly for irradiating samples of fuel elements at controlled temperatures of 80 to 2000°C and a maximum integral neutron flux of 10^{22} neutrons/cm^2. (TTT)

43822 SPECIAL CHARACTERISTICS OF THERMAL NEUTRONS FROM THE OPEN-TANGENTIAL BEAM HOLE OF THE IVV-2 REACTOR. Goshchitskii, B. N.; Gusev, V. V.; Konstantinov, L. V.; Korotovskikh, P. M.; Sidorov, S. K.; Chernobrovkin, V. V.; Chudinov, V. G. At. Energ. (USSR) 28: 425-6(May 1970). (In Russian).

The time-of-flight method was used to determine the energy spectrum of the thermal neutrons extracted from the GEK-5 beam hole by scatterers. Examination of the dependence of the thermal flux intensity ϕ on the neutron wave length λ, determined at a reactor power level of 1 MeV involved the use of graphite and plastic scatterers. The spectra were not affected by changing the relative position of the scatterers from perpendicular to 30° with respect to the axis of the beam hole. It was found that the neutron flux is sharply decreased at critical wave lengths corresponding to twice the Maxwellian scattering between the crystal planes of the graphite. Comparison of the thermal-neutron spectra from tangential and radial beam holes, measured at a reactor power level of 6 MeV revealed that at $T_0 = 320$°K for the tangential and $T_0 = 365$°K for the radial GEK-3 beam holes, respectively, the spectra exhibit a Maxwellian distribution. This softening of the thermal-neutron spectrum is one of the special characteristics of this beam hole. (TTT)

43823 FAST FLUX TEST FACILITY FOR DEVELOPING BREEDER REACTOR TECHNOLOGY. Astley, E. R.; Kelly, J. C. R. Jr. (Westinghouse Electric Corp., Pittsburgh). Kerntechnik; 12: 280-2(Jul 1970).

The Fast Flux Test Facility is described. The core design, refueling system, core instrumentation, irradiation facilities, reactor vessel, and containment are reviewed. The main difficulties in designing the core were the high availability needed and the mass of test instrumentation and test loop piping. (auth)

43824 JAPAN MATERIALS TESTING REACTOR. Makiura, Ryutaro (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Toshiba Rebyu; 25: 901-8(Jul 1970). (In Japanese).

The general plan of the plant and the construction and test operations are described. (auth) (Japan)

43825 STUDY OF IMPACT STRESS IN A VERTICAL NUCLEAR REACTOR CHANNEL. Maserati, A.; Gieb, P. (EURATOM-CCR, Ispra, Italy). Nucl. Eng. Design; 12: 407-20(1970).

The energy absorbed by a SAP (Sintered Aluminum Powder) nuclear reactor channel, during an impact, was evaluated, and the deviation of the $\sigma = \sigma(\epsilon)$ curve from that determined in a static test was investigated at the working strain rates by means of an energy balance equation. No noticeable variation has been found. The influence of the type of rolled joint between the SAP tube and the stainless steel extensions on the resistance at fracture was also investigated, and the most resistant type of junction assessed. (auth)

43826 TIME-OPTIMAL DIGITAL CONTROL OF ZERO POWER NUCLEAR REACTORS. Marciniak, Thomas J. (Argonne National Lab., Ill.). Nucl. Appl. Technol.; 8: 401-16 (May 1970).

A simple, stable, time optimal, digital control program has been developed with general application to zero or low power nuclear reactors for power level changes, especially power increases. The program is required to increase the power level while maintaining a minimum allowed period, and to reach the demand power with little or no overshoot. A switching criterion was derived using a discrete version of the Pontryagin Maximum Principle. The switch point was found to be dependent upon the minimum allowed period and the maximum reactivity removal rate of the controlled regulating rod. The control program developed was applied to digital simulation of three reactor models and was adapted for use on the Argonne Thermal Source Reactor (ATSR) for power level changes. The maximum overshoot experienced was about one percent for various minimum allowed reactor periods and reactivity removal rates. (23 references.) (auth)

Rocket and Space Reactors

43827 OPERATIONAL CHARACTERISTICS OF NUCLEAR ROCKETS. Buden, David (Aerojet Nuclear Systems Co., Sacramento, Calif.). J. Spacecraft Rockets; 7: 832-6(Jul 1970).

The start-up, full-power operation, and shutdown (including afterheat removal from the nuclear reactor) stages of operation of the Nuclear Engine for Rocket Vehicle Application (NERVA) have been demonstrated in the technology program. Start-up is initiated by opening the valve that isolates the engine from the liquid-hydrogen run tank. Two engine systems with unfueled nuclear reactors have been used to investigate this portion of engine operation. A bootstrap technique has been developed that does not depend on auxiliary starting equipment. With the addition of a fueled reactor, as in NRX/EST or XE-P, the energy from the reactor is used to sustain operation or increase to full power. Operation at rated conditions can be sustained for long periods: NRX-A6 has demonstrated a reactor life of 1 hr. Throttling capability allows operation between 60% and 100% thrust at full specific impulse. After shutdown, a period of several days is needed to remove the delayed energy (radioactive decay) from the nuclear reactor by intermittently pulsing propellant through the reactor. (auth)

43828 ACOUSTIC STUDIES DURING GROUND TESTING OF AN EXPERIMENTAL NUCLEAR ROCKET ENGINE. Fairall, R. S.; Thompson, W. R.; Cornell, A. D. (Aerojet Nuclear Systems Co., Sacramento, Calif.). J. Spacecraft Rockets; 7: 977-82(Aug 1970).

The factors necessary to define the acoustic field resulting from ground testing of an experimental nuclear rocket engine were investigated in scale-model tests and at various reactor power levels of the 50,000 lb thrust XE-Engine. Approximately 500 acoustic measurements were made; over-all and spectral analyses were performed to provide data for evaluation of acoustic prediction techniques. The mechanical jet power of the combusting hydrogen-rich gas jet ranged up to 190 MW; the average mechanical-power-to-acoustic-power efficiency was 0.32%, whereas the thermal-power-to-acoustic-power efficiency was 0.0023%. Acoustic power was enhanced by the combustion process in the octave bands centered at 50, 100, and 200 Hz. The predicted value of the over-all sound pressure level at engine full power operation was about 1 db higher than the measured value. (12 references.) (auth)

Process Heat and Desalination Reactors

Refer also to abstract 41393.

43829 (ORNL-HUD-11) THE SITING OF NUCLEAR REACTORS AS RELATED TO URBAN HEAT SUPPLY. Piper, H. B.; West, G. L. Jr. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 26p. Dep. CFSTI.

An analysis of siting practice in the United States and foreign countries indicates that significant steps are being taken in the direction of siting in urban areas with populations of the size and density to benefit from the economical distribution of thermal energy. The AEC approves sites on the basis that there is no undue hazard to the health and safety of the public. Since today's remote site may be tomorrow's metropolitan area, reliance is being placed on engineered safety features to prevent the release of fission products to the environment. It is expected that more operating experience with commercial nuclear power stations will further the trend toward greater reliance on engineered safety features and less on distance from population centers. (19 references.) (auth)

43830 (ORNL-TM-2899) ECONOMIC COMPARISON OF SINGLE-PURPOSE AND DUAL-PURPOSE NUCLEAR PLANTS FOR SUPPLYING WIDELY SEPARATED POWER AND WATER LOADS. Bowers, H. I. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 69p. Dep. CFSTI.

Two alternative situations for satisfying base-load water and electric power requirements were compared. In one, a single-purpose desalting plant located at a coastal site supplies water for use near the coastal site and a separate single-purpose electric power plant located near a distant load center supplies electric power for the load center. In the other, a dual-purpose plant at a coastal site supplies water for use nearby and supplies electric power to the distant load center over high-voltage transmission lines. Plant sizes of 250 Mgd/500 MW(e), 500 Mgd/1000 MW(e), and 1000 Mgd/2000 MW(e) were investigated. All savings in total annual costs were assumed to be available to pay for transmission of electric power from the dual-purpose plants to the distant load centers. Break-even transmission distances were found to be greater than 500 miles for single full-capacity lines and from 370 miles to over 500 miles for two parallel full-capacity lines each carrying half load. (14 references) (auth)

43831 SHEVCHENKO NUCLEAR COMPLEX. Tchourine, Alexandre. Energ. Nucl. (Paris); 12: 117-24(Mar-Apr 1970). (In French).

The basic characteristics of the BN-350 nuclear power station are given. The seawater distillation plant operating at Shevchenko is also described. (auth) (France)

Marine and Portable Power Reactors

Refer also to abstract 41396.

43832 (CONF-700211-2) SHIELDING IN NUCLEAR SHIPS. Kataoka, Iwao. Translated from Japan Atomic Energy Society Meeting, Tokyo, February 12-13, 1970. 11p. Dep. CFSTI.

Analysis of optimum shielding configurations and materials for propulsion reactors is presented. (D.C.C.)

43833 (CONF-700211-5) COUNTERMEASURES AGAINST VIBRATION AND OSCILLATIONS OF SHIP REACTORS. Takada, Yoshio. Translated from Japan Atomic Energy Society Meeting, Tokyo, February 12-13, 1970. 10p. Dep. CFSTI.

Analysis of vibrations in water-cooled propulsion reactors is presented. Sources of vibrations are discussed. The effects of design alterations on elimination of vibrations are analyzed. 5 references. (D.C.C.)

43834 (DOCKET-50238-64) N. S. SAVANNAH. Facility License No. NS-1. Technical Specifications, Change No. 9. (Division of Reactor Licensing (AEC), Washington, D. C.). 7 Aug 1970. 2p. Dep. CFSTI.

Safety requirements for the ship while in port and in a "cold iron condition" are revised. (D.C.C.)

43835 (DOCKET-50238-65) N. S. SAVANNAH. Failure of Control Rod to Drive In. (First Atomic Ship Transport, Inc., New York). 4 Aug 1970. 5p. Dep. CFSTI.

43836 NUCLEAR SUBMARINES CAN BE AN ECONOMIC ALTERNATIVE FOR OIL TRANSPORT UNDER ICE. Heggstad, K. M. (Sjoeforsvarets Forsyningskommando, Haakonsvern, Norway). Tek. Ukebl.; 117: 30-1(12 Feb 1970). (In Norwegian).

The advantages of submarine transport of oil from the Alaskan oilfields are stated, and the reasons for choosing nuclear power are discussed. (J.I.W.) (Norway)

43837 N/S OTTO HAHN: GERMANY'S FIRST ATOMIC POWERED MERCHANT SHIP. Bianchi, Helmut (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Hamburg). Tek. Ukebl.; 116: 1248-52(11 Dec 1969). (In Norwegian).

The hull and machinery of the 15,000 ton ore carrier are described with emphasis on the reactor. There is a brief note on cruising experience, followed by an outline of the future plans including port entry negotiations, and of the current situation for atomic powered merchant ships. (J.I.W.) (Norway)

43838 NAVAL NUCLEAR PROPULSION PROGRAM, 1970. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-FIRST CONGRESS, SECOND SESSION, MARCH 19 AND 20, 1970. Washington, D. C.: Joint Committee on Atomic Energy (1970). 329p. GPO $1.25.

Production Reactors

43839 (BNWL-SA-3465) STUDIES ON THE BIOLOGICAL EFFECTS OF THERMAL DISCHARGES FROM NUCLEAR REACTORS TO THE COLUMBIA RIVER AT HANFORD. Templeton, William L.; Coutant, Charles C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1970]. Contract AT(45-1)-1830. 35p. (CONF-700810-38; SM-146/33). Dep. CFSTI.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Highlights of some of the research carried out over the past twenty-five years on the biological effects of elevated water temperatures on fish and other aquatic life of the Columbia River are presented. The work embraces all of the life stages of salmon, including the eggs, the fry, the juveniles, and the adults. New technology was developed to evaluate the risks to young salmon as they pass the reactor discharges en route to the sea. Field and laboratory data were combined to create a hybrid computer model that predicts the hazards to young fish in the mixing zones. The behavior of adult salmon and trout on their spawning migration upstream past the reactor discharges was studied with the use of sonic tags. Some fish diseases are known to be aggravated by increases in temperature, and studies were made on the incidence of the bacterial disease columnaris and on "gas bubble" disease that results from a supersaturation of nitrogen gas. In addition to the studies concerned with direct effects of thermal increases on fish, investigations have also been made on key elements of the river ecosystem. These include effects on the dynamics of the periphyton community, the development of bottom-dwelling invertebrate organisms and the long-term changes in the size of the chinook salmon population that spawns in the near vicinity of the reactors. (15 references) (auth)

43840 (DUN-SA-132) ^{236}U AND ^{237}Np BUILDUP DATA FROM GRAPHITE-MODERATED REACTORS. Toffer, H. (Douglas United Nuclear, Inc., Richland, Wash.). 8 Jun 1970. 8p. (CONF-700608-17). Dep. CFSTI.

From American Nuclear Society Meeting, Los Angeles, Calif.

Experiments are described for analyzing isotopic compositions of fuel elements as a function of spatial location and exposure time. Such data are of value in correlating experimental isotopic compositions with calculational techniques. The buildup of ^{236}U and ^{237}Np for tubular uranium metal fuel elements in the graphite-moderated water-cooled Hanford single-pass reactors is investigated. (D.C.C.)

Reactor Theory

Refer also to abstract 41891.

Kinetics

Refer also to abstracts 43720, 43723, 43801, and 43826.

43841 (BMI–1888) ADEP-1 AND ADEP-2: ONE-AND TWO-DIMENSIONAL FEW-GROUP KINETICS CODES. Denning, Richard S. (Battelle Memorial Inst., Columbus, Ohio). Aug 1970. Contract W-7405-eng-92. 15p. Dep. CFSTI.

The ADEP-1 and ADEP-2 codes, developed for use in the reactor safety program, solve the few-group, neutron-diffusion equations in time and one or two spatial dimensions, respectively. The present version of each code is restricted to Cartesian co-ordinates and two energy groups. Lumped parameter thermal-hydraulic equations are used for the calculation of feedback. Two types of alternating-direction, explicit integration schemes are permitted at the option of the user. (8 references) (auth)

43842 (DP-Report–357) A METHOD OF CALCULATING RESONANCE INTEGRALS IN GRAPHITE MODERATED HETEROGENEOUS REACTORS. Project DRAGON. Fossoul, E.; Meyvaert, N.; Servais, F. (Societe Belge pour l'Industrie Nucleaire, Brussels). Jun 1965. Contract CON/WIN/57006. 77p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

In graphite moderated heterogeneous systems, in which the fuel contains more or less important amounts of Pu, the strong resonance of ^{240}Pu at 1.05 eV produces a significant flux dip, depending on fuel lumps size, on fuel temperature and on the graphite to plutonium ratio. An account is given of a method which allows the calculation of effective multigroup cross sections in a specified energy range. These permit the use of existing multigroup programs using a coarse group structure. An analytical general method for evaluating the fine structure in a group, for heterogeneous systems, based on Cadilhac's synthetic model for describing thermalization, and a numerical programme permitting the tabulation of effective cross sections as a function of various parameters for two regions systems, specifically adapted to Dragon Reactor, when significant quantities of Pu are present, are presented. 19 references. (auth)

43843 (EUR–4490) SQUIRREL: A FORTRAN IV ONE-DIMENSIONAL FEW-GROUP DIFFUSION-DEPLETION CODE WHICH INCLUDES THE EFFECTS OF LOCAL POWER AND WATER DENSITY. Salina, E. (FIAT, Turin (Italy). Sezione Energia Nucleare). 8 Apr 1970. 132p. Dep. CFSTI (U. S. Sales Only). EUR FF 19.45.

SQUIRREL is a few group one-dimensional lifetime program written in FORTRAN IV for the IBM-360/65. The diffusion equations are solved by the three point finite difference method. The mesh interval can be assigned an arbitrary length provided the interfaces between different material regions at the beginning of the lifetime lie on mesh points. Slab, cylindrical and spherical geometry problems can be dealt with. The burnup calculations are carried out by mesh interval. Six types of criticality searches can be carried out. At each time-step a fuel shuffling may be carried out. The effect of the water density on the same cross-section is accounted for. The program calculates the water number density at each mesh interval as a function of the local power through the enthalpy. 7 references. (auth)

43844 (FEI–177) COMPARISON OF THE POINT AND SPACE KINETICS MODELS IN A URANIUM–HYDRIDE REACTOR. Mogil'ner, A. I.; Dimeshi, Z.; Kolosov, B. I.; Krivelev, G. P.; Morozov, S. A.; Satmari, Z.; Semenov, E. F.; Stepanov, A. N.; Shvetsov, D. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1969. 37p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The point model of kinetics describes satisfactorily the experimental results in case of the periods commensurable with the reciprocal value of the basic constant for the decay of momentary neutrons. In case of the shorter periods (and accordingly at high frequencies), we observe in the statistical experiments a deviation from the point model. This corresponds to the fact that at short periods commensurable with the propagation time of a perturbation through the reactor's space, the latter ceases to behave as an integrated unit. The manifestation of the spatial effects is most perceptible in the experiments with a pulse-type neutron oscillator. The complexity of the statistical experiments precluded obtaining a high precision of the results. These experiments are described quite well within the scope of a two-point model by two decay constants. The calculations conducted for the attenuation decrements indicate that the measured values α_1 and α_2 can correspond to pertinent natural (eigen-) values. The tests made on the propagation of a neutron-type pulse through the active section (core) permit the conclusion that at sufficiently short periods the reactor can be regarded as an infinite medium; within the framework of the single-group approximation, these experiments allow a determination of the $\overline{D\nu}$-value which agrees satisfactorily with the calculation. (JPRS)

43845 (NP–10435) AN ITERATIVE SOLUTION OF THE REACTOR KINETIC EQUATIONS FOR THE ROD DROP AND SOURCE JERK EXPERIMENTS. Project DRAGON. Hage, W.; Cameron, I. R. (Atomic Energy Establishment, Winfrith (England)). Jun 1961. 17p. (DP-Report–39). Dep. CFSTI.

A solution of the reactor kinetic equations which is suitable for application to both the rod drop and source jerk methods for the determination of control element worths is presented. Since the same method of solution can be applied with only minor modifications to both experiments, the mathematical derivation is given in detail for the rod drop case only, and the modification necessary for the source jerk method is considered separately. (auth)

43846 SPACE DEPENDENT CONSIDERATIONS IN THE NON-LINEAR PROMPT NEUTRON KINETICS OF A NUCLEAR REACTOR. Ghatak, Ajoy; Singh, Om Pal (Indian Inst. of Tech., New Delhi). J. Nucl. Energy; 24: 217–21(Jul 1970).

Corrections are obtained for the time dependent reactor power due to the excitation of high spatial modes for a two region reactor using one group diffusion theory. It is assumed that contribution from the higher modes is small, compared with that of the fundamental modes, and hence the calculations are based on the use of perturbation theory. Based on the model developed higher mode contributions are calculated for the graphite moderated pulse reactor TREAT. (UK)

43847 PHYSICAL INTERPRETATION OF THE THEOREM ON THE INTEGRAL OF REACTIVITY. Orlov, V. V.; Stumbur, E. A. At. Energ. (USSR); 28: 353-4(Apr 1970). (In Russian).

Proof had been given for a theorem relating the reactivity integral to the reactivity coefficients at the boundaries of homogeneous zones of the reactor. It is shown that this result is a consequence of the invariance of the neutron transport equation with respect to a similitude transformation. It is assumed that the reactor critical assembly consists of a number of homogeneous zones limited by surfaces with the reactivity changing from one zone to another. A formula is developed to relate the reactivity integral to values of the jumps in reactivity coefficients at the boundaries of all zones. This formula is used to determine the exact neutron flux on the boundary of a bare critical sphere. (TTT)

43848 MODAL PERTURBATION METHOD APPLIED TO DIFFUSION EQUATION. Saito, Reiko (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 7: 371-9(Jul 1970).

A practically convenient method for applying the higher order perturbation theory has been developed. The method "modal perturbation method" is a perturbation method based on the technique of modal expansion. The first advantage of the method is that the calculation of the higher order terms is much simpler in comparison with the standard higher order perturbation method. The procedure for solving the diffusion equation by the new method is described, and an analytical calculation is performed on the higher modes of a bare reactor, followed by examples of practical applications of the method. (9 references) (auth)

43849 APPROXIMATE CALCULATION METHOD OF THE λ, ω_p AND ω_d EIGENVALUE PROBLEM OF THE GROUP DIFFUSION EQUATION. Yoshikawa, Hidekazu; Wakabayashi, Jiro (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 355-65(Jul 1970).

The approximate solutions of the λ, ω_p and ω_d eigenvalue problems of the group-diffusion equation for a multi-region reactor are obtained by expanding neutron fluxes into finite numbers of eigenfunctions satisfying the Helmholtz equation and the boundary condition at the extrapolated boundary of the reactor. The original eigenvalue problem is reduced to that of an asymmetric real matrix for the vector whose components constitute the expansion coefficients. For the numerical calculation of the real matrix

thus derived, to determine the higher λ, ω_p and ω_d modes, the QR iteration method based on numerically stable unitary transformation, in combination with inverse iteration is effective in saving computation time. The λ, ω_p and ω_d modes obtained by the above method are expressed by a linear combination of a comparatively small number of simple elementary functions, and are thus of high practical value in the numerical calculation of higher order perturbations and for examining space-dependent reactor dynamics. (8 references) (auth)

43850 LINEARLY ANISOTROPIC EXTENSIONS OF ASYMPTOTIC NEUTRON DIFFUSION THEORY. Doyas, R. J.; Koponen, B. L. (Univ. of California, Livermore). Nucl. Sci. Eng.; 41: 226-36(Aug 1970).

Anisotropic transport-theory corrections to asymptotic diffusion theory are suggested and evaluated. These modifications are found to provide a natural and useful extension of diffusion-theory applications in one-dimensional, one-region problems. An effort is also made to determine whether the treatment of problems of more than one dimension in one-dimensional codes can be improved through the use of this extended formulation of diffusion theory. (15 references.) (auth)

43851 MONTE CARLO METHOD FOR GEOMETRICAL PERTURBATION AND ITS APPLICATION TO THE PULSED FAST REACTOR. Takahashi, Hiroshi (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 41: 259-70(Aug 1970).

The Monte Carlo method is applied to calculate the reactivity change due to a moving reflector block in the pulsed fast reactor system. This reactivity change is an important quantity in the determination of the power pulse width. In the important region of small displacements about the maximum reactivity point, the reactivity change is so small that the ordinary Monte Carlo methods, using the importance sampling, Russian roulette, or splitting techniques, require prohibitively long calculation times. To avoid this difficulty, a new Monte Carlo method, which directly calculates the geometry coefficient of reactivity due to a geometry perturbation, is developed by adopting the method used in the calculation for the Doppler coefficient by Olhoeft. The formulation of the new method is discussed. The GEMCM code for this geometry perturbation, which is made by modifying the 05R code, is described. Finally, an analysis of the critical experiment for the pulsed fast reactor is carried out using this method and the applicability of the method is discussed. (16 references.) (auth)

Dynamics

43852 SPECTRAL SYNTHESIS APPLIED TO FAST-REACTOR DYNAMICS. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 41: 249-58(Aug 1970).

Spectral synthesis methods, in which the neutron flux spectrum is synthesized from known trial spectra, is applied to fast-reactor dynamics. Numerical results demonstrate that important spectral shift effects which occur during transients are adequately represented by synthesis models with two trial spectra. Conventional few-group models which require equivalent computational effort are found to provide a significantly inferior representation of these effects. (13 references.) (auth)

Experimental Applications

43853 (BNWL-SA-1107) EXPERIMENTS AND CALCULATIONS FOR H_2O-MODERATED ASSEMBLIES CONTAINING UO_2–2 WT. % PuO_2 FUEL RODS. Uotinen, V. O.; Williams, L. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 23 May 1967. Contract AT(45-1)-1830. 33p. (CONF-670602-33). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

Critical experiments were performed in the Plutonium Recycle Critical Facility (PRCF) in six configurations of UO_2–2 wt.% PuO_2 fuel rods. Each rod was made of 1128 g of UO_2–PuO_2 and is 36 in. long, 0.508 in. in diameter, and clad with 0.030 in. of Zircaloy-2. The rods were of three types which had varying weight percents of $^{239}Pu/^{240}Pu/^{241}Pu/^{242}Pu$. The rods were in a hexagonal lattice with a lattice spacing of 0.85 in. and a water-to-oxide volume ratio of 1.83. Single-zone cores and two-zone cores were studied using various combinations of the three fuel types. An effectively infinite H_2O reflector surrounded the core. Measured parameters that are summarized include critical mass; spatial flux and power distributions; power peaking and power sharing; bucklings, reflector savings; worth of fuel rods; moderator void worth; moderator level reactivity coefficient; moderator temperature reactivity coefficient; and the ratio of effective delayed-neutron fraction to mean neutron lifetime. Calculations were performed using the codes HRG, THERMOS, and TEMPEST to obtain four energy-group, cell-averaged cross sections, and HFN to calculate multiplications and spatial distributions of power and flux. 20 references. (auth)

43854 (CEA-N-1179) PRINCIPLE OF A CODE ADAPTED TO THE SOLVING OF PROBLEMS OF CRITICALITY BY THE MONTE CARLO METHOD. Moreau, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1970. 30p. (In French). Dep. CFSTI (U. S. Sales Only).

The principle is given of a code which makes it possible to resolve problems of criticality with a satisfactory representation of the geometry and in acceptable computing time. Only the processing of data concerning the geometry is utilized. It is shown, with the help of a few conventional examples of criticality, what the possibilities are of such a code based on the proposed principle. Certain sequences corresponding to important aspects of the principle are described. (auth) (France)

43855 (CEA-R-3985) POWER DISSIPATED IN THE GRAPHITE AND THE CO_2 OF A GRAPHITE REACTOR CELL. Barre, Bertrand; Brisbois, Jacques; Lott, Michel; Oceraies, Yves; Noel, Jean-Paul; Manent, Georges; Fiche, Charles; Ribeiro, Fernando; l'Homme, Alain (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1970. 150p. (In French). Dep. CFSTI (U. S. Sales Only).

The experiments carried out in the NAIADE II subcritical assembly are described. They concern the ionization of CO_2 in the fuel channel and the graphite pores. The experimental work is effected in the moderator with ionization chambers of graphite filled with CO_2, and of polythene filled with ethylene, and in the channel with a chamber containing the fuel element. The results are compared with the theoretical results obtained with the methods used in power reactor calculations. The observed agreement is excellent, the dispersion of about 5% being of the same order as the experimental uncertainties. (auth)

43856 REACTION RATES IN REPRESENTATIVE PLUTONIUM-RECYCLE FUEL LATTICES. Carver, J. G.; Morgan, W. R.; Porter, C. R.; Robkin, M. A. (General Electric Co., Pleasanton, Calif.). Nucl. Sci. Eng.; 41: 209-25(Aug 1970).

Measurements were made of relative nuclear-reaction rates within subcritical water-moderated plutonia-urania fuel lattices, under conditions considered typical for plutonium recycle in central-station power reactors. Measurement conditions included water : fuel ratios of 3 : 1 and 2 : 1; temperatures of 70, 235, 330, 430, and 540°F; and three positions within the unit cell. Nuclear reaction rates measured included relative fission rates in ^{235}U, ^{239}Pu, and ^{241}Pu, as well as relative capture rates in ^{176}Lu (principal resonance at 0.143 eV), ^{168}Yb (0.597 eV), ^{191}Ir (0.654 eV), ^{193}Ir (1.303 eV), ^{197}Au (4.906 eV), ^{139}La (73.5 eV), and ^{63}Cu (1/v detector). To facilitate comparison with predicted values, the experimental resonance absorption-rate ratios were normalized to ratios measured within a pure water spectrum. Experimental reaction-rate ratios were compared with values predicted using the THERMØS code in conjunction with a modified version of EPITHERMØS; and agreement varying from fair to good was observed. The internal consistency of the measurements suggests their future utility for evaluating methods of calculating neutron spectra and relative reaction rates within lattices of the type considered. (63 references.) (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 41395, 41396, 41586, 41588, 41613, 41634, 42209, 42212, 42213, 42233, 42284, 42295, and 43686.

43857 (BNWL-1442) PLUTONIUM UTILIZATION PROGRAM. Technical Activities Quarterly Report, March–May 1970. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 103p. Dep. CFSTI.

NEUTRONS—effects on uranium oxide (UO_2) and plutonium oxide (PuO_2)–uranium oxide (UO_2) microstructure, (E)

PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, radiation effects on microstructure of vibrationally compacted, (E)

PLUTONIUM RECYCLE TEST REACTOR—fuel elements for, irradiation performance of Zircaloy clad uranium oxide (UO_2) and plutonium oxide (PuO_2)–uranium oxide (UO_2) rod type

REACTOR FUEL ELEMENTS—power distribution in water cooled rod type uranium oxide (UO_2) and plutonium oxide (PuO_2)–uranium oxide (UO_2), (E/T)

—reactivity worth of water cooled rod type uranium oxide (UO_2) and plutonium oxide (PuO_2)–uranium oxide (UO_2), (E/T)
—radiation effects on Zircaloy clad uranium oxide (UO_2) and plutonium oxide (PuO_2)–uranium oxide (UO_2) rod type, (E)
—burnup of Zircaloy clad uranium oxide (UO_2) and plutonium oxide (PuO_2)–uranium oxide (UO_2) rod type, (E)
—failure of Zircaloy clad uranium oxide (UO_2) and plutonium oxide (PuO_2)–uranium oxide (UO_2) rod type
REACTOR SAFETY—transient behavior of Zircaloy clad uranium oxide (UO_2) and plutonium oxide (PuO_2)–uranium oxide (UO_2) rod type
REACTORS, BOILING—fuel elements for, power distributions and reactivity worth of rod type uranium oxide (UO_2) and plutonium oxide (PuO_2)–uranium oxide (UO_2), (E/T)
URANIUM OXIDES UO_2—PuO_2–UO_2, radiation effects on microstructure of vibrationally compact, (E)
—radiation effects on microstructure of vibrationally compacted, (E) (D.C.C.)

43858 (LA–4453) DESIGN AND FABRICATION OF A THERMAL SCANNER. Meier, Karl L. (Los Alamos Scientific Lab., N. Mex.). Apr 1970. Contract W-7405-eng-36. 9p. Dep. CFSTI.

The thermal scanner is an experimental device used to determine the size and movement of fission product gas bubbles in the bond of a Na-bonded reactor fuel pin. A reactor fuel pin is simulated by a heater, a UC cylinder, and a 10-mil Na bond, all contained in a 10-mil wall, 0.350-in. o.d. stainless steel cylinder that simulates the fuel pin cladding. A He or Ar gas bubble is created in the bond by a micrometer syringe. Thermocouples are used to measure the cladding temperature. Bubbles in the bond cause the cladding temperature to depart from normal. The thermocouple output is interpreted by a computer that produces a temperature map of the cladding surface. Movement of the bubble is determined from successive maps. Status of the experiment is described. 4 references. (auth)

43859 (ORNL-NSIC-76) COMPILATION OF UNITED STATES NUCLEAR STANDARDS. 6th Edition, 1969. (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 177p. Dep. CFSTI.

Standards information that might be of value to an individual in the nuclear community is compiled and presented in tabular form. The technical, industrial, and environmental organizations are listed alphabetically and their standards activities are given. In addition, standards are indexed by permuted title for location by a specific topic. (H.D.R.)

43860 (ORNL-TM-2928) COMPUTER HANDLING OF REACTOR DATA FOR SAFETY: CHORD-S. Cole, T. E.; Heddleson, F. A. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 23p. Dep. CFSTI.

The CHORD-S project was initiated to investigate the feasibility of computerizing reactor design data so that rapid, versatile retrieval of desired information was possible. In data handling and communications networks, it seemed appropriate to make a complete review of the two years of development effort. Post-project evaluation, description, accomplishments, and a complete bibliography for the project are presented. The project proved the feasibility of computerizing reactor design data. An operational system was developed and is being used to obtain general information on about 70 reactors. (auth)

43861 THERMAL STRESSES AND DISPLACEMENTS IN FINITE, HEAT-GENERATING CIRCULAR CYLINDERS. Valentin, Richard A.; Carey, John J. (Argonne National Lab., Ill.). Nucl. Eng. Design; 12: 277-90(1970).

An exact solution is given for the thermal displacements and stresses in a finite, right circular cylinder of homogeneous, isotropic, elastic material having a known radial temperature distribution. The solution rigorously meets traction-free boundary conditions on both the lateral surface and plane ends of the cylinder and provides a graphic illustration of Saint-Venant's principle. Extensive numerical results for the stress field existing in various length cylinders having uniform internal heat generation show both the region of essentially plane-strain and the short, non-plane, transition region near the ends where an appreciable shear component exists. The displacement field at the cylinder surface is given and exhibits a noticeable increase in the radial displacement at the end surface. This extended edge implies, for example, that an initially perfect fuel pellet, just fitting its clad, will, even if clad and fuel have the same coefficient of thermal expansion, make preferential fuel-clad contact at the pellet end. This effect may, therefore, have some importance in explaining the "ridging" phenomena noted in fuel elements consisting of stacked pellets. (11 references) (auth)

43862 THERMAL STRESS IN A FINITE HEAT GENERATING CYLINDER. Matthews, J. R. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Eng. Design; 12: 291-6 (1970).

The displacements and stresses within a finite heat generating cylinder, a problem important as an idealisation of a nuclear fuel pellet, have been calculated over a range of length to diameter ratios, using the finite difference method. At the extreme aspect ratios, the solutions are seen to tend to the expected values for the infinitesimally thin disc and the infinite cylinder. The tensile stresses on the surface of the cylinder vary most rapidly between aspect ratios of 0.5 and 1.0. Cracking is most likely to be initiated at the rim of the cylinder, where the stress σ_θ is dominant for all aspect ratios. The method is compared with other numerical approximations and the errors are estimated. (8 references) (auth)

43863 ANALYSIS OF THERMOELASTIC TRANSIENTS DUE TO LOCAL HEAT TRANSFER COEFFICIENT PERTURBATIONS. Thompson, J. J.; Holy, Z. J. (Univ. of New South Wales, Kensington). Nucl. Eng. Design; 12: 297-312(1970).

The problem of predicting the transient temperature and thermoelastic stress fields induced by a localised, axially symmetric, space and time dependent heat transfer coefficient perturbation on the surface of a constant property heat generating body has been investigated and formulated as a set of coupled integral equations. This problem represents an idealisation of the thermo-mechanical transients associated with bubble growth and detachment on the surface of a fuel element in nucleate boiling. Computer studies of the response to an instantaneous timewise step change have verified the validity of the theoretical development, and the feasibility of the numerical treatment, while confidence in the results has been established by comparison with the output from a purely numerical finite difference approach. (11 references) (auth)

43864 NUMERICAL STUDIES OF TEMPERATURE AND THERMOELASTIC STRESS DUE TO LOCAL HEAT TRANSFER COEFFICIENT TRANSIENTS. Thompson, J. J.; Holy, Z. J.; Chen, P. (Univ. of New South Wales, Kensington). Nucl. Eng. Design; 12: 313-25(1970).

A number of results are presented from the application of a Laguerre function expansion method to the study of temperature and thermoelastic stress resulting from local symmetric surface heat transfer coefficient transients on the surface of a heat generating body, relevant to problems of boiling in water cooled reactors. Details are also given of the approximate solution of the parabolic heat conduction equations and the calculation of the maximum thermoelastic stress in these problems, by a finite difference approach, using an alternating direction explicit process and a local one-dimensional method. (7 references) (auth)

43865 INELASTIC ANALYSIS OF BOWING IN MULTISPAN FUEL RODS SUBJECTED TO AXIAL THRUST. PART II. INTERACTION BETWEEN BOWING AND HEAT TRANSFER PROCESSES. Newman, John B. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Eng. Design; 12: 326-43(1970).

Bowing of multispan rod-type fuel elements depends upon axial thrust, heat generation gradients, and variations in heat transfer processes. The analysis needed to extend the results of an earlier paper to include the effects of interaction between rod deflections and coolant flow is presented. It is assumed that the material properties of the rod can be adequately represented by material properties associated with an axisymmetric temperature distribution, and that perturbations to the flow field are small enough that linearized equations can be used. (auth)

43866 IRRADIATION PERFORMANCE OF PYROLYTIC-CARBON- AND SILICON-CARBIDE-COATED FUEL PARTICLES. Reagan, P. E.; Long, E. L. Jr.; Morgan, J. G.; Coobs, J. H. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 8: 417-31(May 1970).

The fission-gas release from pyrolytic C coated fuel particles was measured during irradiation, and the damage to the coating material and to the fuel was studied by postirradiation metallography. These particles were either UO_2, UC, or ThC–UC with a porous C primary coating. Particles coated with dense pyrolytic C and those coated with a combination of pyrolytic C and SiC layers performed well during irradiation in the 1250–1400°C range, but both suffered severe internal reactions in the 1650–1700°C temperature range, even at low burnup. With one exception, all the experiments were conducted at a much higher burnup rate than would be encountered under normal power reactor conditions. (12 references.) (auth)

GENERAL

43867 (AECL–3568) A SURVEY OF ANALYTICAL AND NUMERICAL METHODS FOR INTEGRATING FOURIER TRANSFORMS. Jarvis, R. G. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1970. 49p. Dep. CFSTI (U. S. Sales Only). AECL $1.50.

43868 (ANL–7556) THE QUAD SCHEME: A NEW METHOD FOR PHASE SPACE INTEGRATION. Mueller, F. M.; Garland, J. W.; Cohen, M. H.; Bennemann, K. H. (Argonne National Lab., Ill.). Mar 1969. Contract W-31-109-eng-38. 43p. Dep. CFSTI.

43869 (ANL–7702) HARTREE–FOCK WAVE FUNCTIONS AND COMPUTED ONE-ELECTRON PROPERTIES FOR OXYGEN MONOFLUORIDE (OF, $^2\Pi$) AT SIX INTERNUCLEAR SEPARATIONS. O'Hare, P. A. G.; Wahl, Arnold C. (Argonne National Lab., Ill.). Jun 1970. Contract W-31-109-eng-38. 12p. Dep. CFSTI.

43870 (BNWL–1466) TECHNOLOGICAL FORECASTING. Fields, S. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 26 Jun 1970. Contract AT(45-1)-1830. 68p. Dep. CFSTI.

43871 (BRH/DBE–70-1, pp 3) BIOMETRY SECTION. (Public Health Service, Rockville, Md.).

The Biometry Section provides statistical and mathematical consultation, experimental design, and data analysis services to all sections for radiobiological investigations. The section also develops mathematical models to characterize physical or biological systems and cooperates with the investigator to define experimental objectives. (H.L.W.)

43872 (COO–588-19) THE TRANSITION PHASE IN TiNi. Sandrock, G. D.; Hehemann, R. F. (Case Western Reserve Univ., Cleveland, Ohio. Div. of Metallurgy and Materials Science). 31 Jul 1970. Contract AT(11-1)-588. 61p. Dep. CFSTI.

43873 (COO–1422-76) TISSUE CHANGES FOLLOWING VENOUS OCCLUSION USING PHOTON ABSORPTIOMETRY. Mazess, Richard B. (Wisconsin Univ., Madison). [1970]. 3p. Dep. CFSTI.

43874 (COO–1422-80) THE BONE MINERAL CONTENT OF THE PHALANX OF CHRONIC HEMODIALYSIS PATIENTS. Judy, Philip F.; Beirne, G. J.; Cameron, J. R. (Wisconsin Univ., Madison). [1969]. 3p. Dep. CFSTI.

43875 (COO–1422-81) MINERAL CONTENT AND COMPRESSIVE STRENGTH OF CANCELLOUS BONE. Wilson, C. R.; Disterhoft, S.; Cameron, J. R. (Wisconsin Univ., Madison. Dept. of Radiology). [1970]. Contract AT(11-1)-1422. 10p. Dep. CFSTI.

43876 (COO–1422-83) REVIEW OF BODY COMPOSITION RESEARCH AT THE UNIVERSITY OF WISCONSIN 1960–1970. Cameron, John R. (Wisconsin Univ., Madison). Jul 1970. Contract AT(11-1)-1422. 28p. Dep. CFSTI.

43877 (COO–1488-19 THEORY OF HYPERFINE ESR LINEWIDTH IN A LINEAR CHAIN: $Cu(NH_3)_4SO_4 \cdot H_2O$. McElwee, Carl D. (Kansas Univ., Lawrence). 30 Jun 1970. Contract At(11-1)-1488. 30 p. Dep. CFSTI.

43878 (COO–1488-21) FINAL REPORT [ON DYNAMIC ASPECTS OF CONCENTRATED MAGNETIC SYSTEMS]. Richards, Peter M. (Kansas Univ., Lawrence. Dept. of Physics). Jun 1970. Contract AT(11-1)-1488. 12p. Dep. CFSTI.

43879 (COO–1627-11) PHOTO-INITIATED PROCESSES IN VISION. Technical Progress Report, November 14, 1969–November 15, 1970. Guzzo, Anthony V. (Wyoming Univ., Laramie. Dept. of Chemistry). [1969]. Contract AT(11-1)-1627. 7p. Dep. CFSTI.

43880 (IN–1411) TWO CONTRIBUTIONS TO THE THEORY OF DIGITAL FILTERING. Connelly, A. L. (Idaho Nuclear Corp., Idaho Falls). Jul 1970. Contract AT(10-1)-1230. 37p. Dep. CFSTI.

43881 (LA–4269) METHOD OF CHARACTERISTICS FOR ONE-DIMENSIONAL FLOW WITH CHEMICAL REACTION. Fickett, W.; Jacobson, J. D.; Wood, W. W. (Los Alamos Scientific Lab., N. Mex.). Aug 1969. Contract W-7405-eng-36. 57p. Dep. CFSTI.

43882 (LA–4464) METHOD OF COMPUTING FLUID MOTION IN TWO-DIMENSIONAL CARTESIAN OR CYLINDRICAL COORDINATES BY FOLLOWING LAGRANGIAN ENERGY CELLS. Blewett, Patrick J. (Los Alamos Scientific Lab., N. Mex.). May 1970. Contract W-7405-eng-36. 10p. Dep. CFSTI.

43883 (LA–4470) SIGNIFICANT DIGIT ARITHMETIC ON A CDC 6600. Gardiner, V.; Metropolis, N. (Los Alamos Scientific Lab., N. Mex.). Jun 1970. Contract W-7405-eng-36. 4p. Dep. CFSTI.

43884 (LA–4481) TARGET-DESIGN AND DATA-REDUCTION CODES FOR THE ARLG GUN. Fritz, J. N.; Morgan, J. A. (Los Alamos Scientific Lab., N. Mex.). Jun 1970. Contract W-7405-eng-36. 30p. Dep. CFSTI.

43885 (LA-tr–70-16) FORMATION OF A SOLID SOLUTION OF LITHIUM FLUORIDE AND LITHIUM HYDRIDE. Hahn, H.; Strick, G. Translated for Los Alamos Scientific Lab., N. Mex., from Z. Anorg. Allg. Chem.; 372: 248(1970). 4p. Dep. CFSTI.

43886 (MLM–1750) STABLE ISOTOPE SALES: MOUND LABORATORY CUSTOMER AND SHIPMENT SUMMARIES, FY-1969. Williams, M. J. (comp.) (Mound Lab., Miamisburg, Ohio). 31 Jul 1970. Contract AT(33-1)-Gen-53. 21p. Dep. CFSTI.

43887 (NYO–2472-68) VIBRATIONAL ANISOTROPY AND GOL'DANSKII–KARYAGIN EFFECT IN TRIMETHYLTIN CYANIDE. Herber, Rolfe H.; Chandra, Subhas (Rutgers-The State Univ., New Brunswick, N. J. School of Chemistry); Hazony, Yehonathan (Princeton Univ., N. J. Dept. of Chemical Engineering). [1969]. 25p. (NYO–2807-78). Dep. CFSTI.

43888 (NYO–2651-24) LOCALIZATION OF ANTIBODIES IN SPONTANEOUS AND INDUCED TUMORS. Progress Report, July 1, 1969–June 30, 1970. Pressman, David (Roswell Park Memorial Inst., Buffalo, N. Y.). Jul 1970. Contract AT(30-1)-2651. 5p. Dep. CFSTI.

43889 (NYO–2798-52) CRYSTAL AND MOLECULAR STRUCTURE OF A THYMINE PHOTOTRIMER. Flippen, J. L. (Johns Hopkins Univ., Baltimore, Md. School of Hygiene and Public Health). [1970]. 9p. Dep. CFSTI.

43890 (NYO–3838-5) ANALYSIS OF SEA WATER BY DIFFERENCE CHROMATOGRAPHY. Summary of Progress, 1969–70. Mangelsdorf, Paul C. Jr.; Wilson, T. Roger S. (Woods Hole Oceanographic Institution, Mass.). Contract AT(30-1)-3838. 21p. Dep. CFSTI.

43891 (NYO–4048-2) INFLUENCE OF IODINE INTAKE UPON KINETICS OF IODINE METABOLISM IN THE DOG. Progress Report, November 1, 1968–October 31, 1970. (Cornell Univ., New York. Medical Coll.). Contract AT(30-1)-4048. 69p. Dep. CFSTI.

43892 (NYO–4051-11) THE TOXICOLOGY OF NICKEL CARBONYL. Progress Report. Sunderman, F. William Jr. (Connecticut Univ., Hartford. Dept. of Lab. Medicine). 1 Aug 1970. 10p. Dep. CFSTI.

43893 (ORNL–4571) X-RAY DIFFRACTION DATA ON LIQUID TRIMETHYLAMINE DECAHYDRATE AT 5°C. Folzer, Cynthia (Pittsburgh Univ., Pa. Dept. of Crystallography); Hendricks, R. W.; Narten, A. H. (Oak Ridge National Lab., Tenn.). Aug 1970. 36p. Dep. CFSTI.

43894 (ORNL–TM–2968) WALKER BRANCH WATERSHED PROJECT: CHEMICAL, PHYSICAL AND MORPHOLOGICAL PROPERTIES OF THE SOILS OF WALKER BRANCH WATERSHED. Peters, L. N.; Grigal, D. F.; Curlin, J. W.; Selvidge, W. J. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 96p. Dep. CFSTI.

43895 (ORNL–TM–3001) CONCENTRATION AND DESALTING OF PROTEIN SOLUTIONS PROGRAM. Progress Report for the Period, September 1–November 30, 1969. Hancher, C. W.; Ryon, A. D.; Rogers, F. L. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 29p. Dep. CFSTI.

43896 (ORNL–TM–3056) NEW TECHNIQUE FOR ULTRASONIC FLAW DETERMINATION BY SPECTRAL ANALYSIS. Whaley, H. L.; Adler, Laszlo (Oak Ridge National Lab., Tenn.). Sep 1970. Contract W-7405-eng-26. 40p. Dep. CFSTI.

43897 (ORNL-tr-2351) SOME DATA CONCERNING THE BOTTOM TEMPERATURES OF THE RYBINSKO RESERVOIR IN THE PERIOD WHEN THE RESERVOIR IS COVERED BY ICE. Bakastov, S. S. Translated for Oak Ridge National Lab., Tenn., from Byull. Inst. Biol. Vodokran. Akad. Nauk SSSR; No. 8/9, 62-6 (1960). 7p. Dep. CFSTI.

43898 (ORNL-tr-2374) CRYSTALLINE STRUCTURE OF HIGH TEMPERATURE SILVER IODIDE α-AgI. Strock, Lester W. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Z. Phys. Chem. (Leipzig); 25B: 441-59(1934). 17p. Dep. CFSTI.

43899 (ORO-3443-28) NUMERICAL STABILITY IN PROBLEMS IN LINEAR ALGEBRA. Babuska, Ivo (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Jun 1970. 33p. (BN-663; CONF-700617-1). Dep. CFSTI.
From SIAM National Meeting, Denver, Colo.

43900 (ORO-3845-2) [THE INTERRELATIONSHIP OF HYDRODYNAMICAL PROCESSES AND ORGANIC PRODUCTION IN THE OCEAN]. Progress Report. (Nova Univ., Fort Lauderdale, Fla.). May 1970. Contract AT(40-1)-3845. 4p. Dep. CFSTI.

43901 (RLO-1725-180) COLUMBIA RIVER EFFECTS IN THE NORTHEAST PACIFIC. Progress Report, June 1969-June 1970. Barnes, Clifford A. (comp.) (Washington Univ., Seattle. Dept. of Oceanography). 10 Jul 1970. Contract AT(45-1)-1725. 47p. Dep. CFSTI.

43902 (RLO-2017-2) TECHNETIUM AS A CATALYST IN ORGANIC REACTIONS. Progress [Report]. (Brigham Young Univ., Provo, Utah). 28 Apr 1970. Contract AT(45-1)-2017. 4p. Dep. CFSTI.

43903 (SC-DR-70-206) USE OF OPTICAL TRANSFORMS FOR ANALYSIS OF ACOUSTIC AND SEISMIC DATA. Scharrer, R. G. (Sandia Labs., Albuquerque, N. Mex.). Apr 1970. 20p. Dep. CFSTI.

43904 (SC-DR-70-217) SANDIA 500-KILOJOULE ARC-DRIVEN SHOCK TUBE FACILITY. Mulac, A. J.; Mark, J. L.; Guzman, J. A. (Sandia Labs., Albuquerque, N. Mex.). Jun 1970. 45p. Dep. CFSTI.

43905 (SC-RR-70-65) EXPLODING WIRES AS SHOCK-WAVE SOURCES. Carlson, G. A. (Sandia Labs., Albuquerque, N. Mex.). Jul 1970. 24p. Dep. CFSTI.

An exploding wire can be a highly efficient shock-wave source. An exploding-wire system is reported which produces shock waves at about 50 percent efficiency over two orders of magnitude in stored electrical energy (0.11 to 12.5 joules). The efficiency of exploding wires is related to the physical and electrical processes occurring during wire explosions. (auth)

43906 (SC-RR-70-413) FLUSH-MOUNTED ELECTROSTATIC PROBE IN THE PRESENCE OF NEGATIVE IONS. Touryan, K. J. (Sandia Labs., Albuquerque, N. Mex.); Chung, P. M. (Illinois Univ., Chicago). Jul 1970. 38p. Dep. CFSTI.

43907 (SC-RR-70-433) THIN-WIRE CIRCULAR LOOP ANTENNAS OF ARBITRARY SIZE. Licking, L. D.; Merewether, D. E. (Sandia Labs., Albuquerque, N. Mex.). Aug 1970. 75p. Dep. CFSTI.

43908 (SC-RR-70-497) COMPUTER AIDED DESIGN OF MICROWAVE TRIODE OSCILLATORS. Chaffin, R. J. (Sandia Labs., Albuquerque, N. Mex.). Jul 1970. 42p. Dep. CFSTI.

43909 (SC-RR-70-537) GRADIENT SHOCK TUBES WITH STRONG INCIDENT SHOCK WAVES IN HYDROGEN. Freiwald, D. A. (Sandia Labs., Albuquerque, N. Mex.). Aug 1970. 40p. Dep. CFSTI.

43910 (SCL-DR-70-83) MEASUREMENT CAPABILITIES OF THE SANDIA LABORATORIES, LIVERMORE, STANDARDS LABORATORIES. Wilson, J. L. (Sandia Labs., Albuquerque, N. Mex.). Aug 1970. 28p. (SCL-DR-67-81). Dep. CFSTI.

43911 (TID-3759) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Issued or in Progress During the Period May-June 1970. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 10p. DTIE Free.

43912 (TID-5059(10th Rev.)) CORPORATE AUTHOR HEADINGS USED BY THE U. S. ATOMIC ENERGY COMMISSION IN CATALOGING REPORTS. (Division of Technical Information Exetension (AEC), Oak Ridge, Tenn.). Jul 1970. 189p. CFSTI.

43913 (TID-25485) ENERGY METABOLISM AND ITS CONTROL IN HIGHER PLANTS. Progress Report, September 1968-July 1970. Bonner, Walter D. Jr. (Pennsylvania Univ., Philadelphia. Johnson Research Foundation). 13 Jul 1970. Contract AT(D-1)-3729. 30p. Dep. CFSTI.

43914 (UCLA-34-P-88-28(Rev.)) HIGH-PRESSURE RAMAN SPECTRA OF HEXAGONAL ZINC SULFIDE. Ebisuzaki, Y.; Nicol, M. (California Univ., Los Angeles. Dept. of Chemistry). [1969]. Contract AT(11-1)-34. 9p. (CONF-700329-1). Dep. CFSTI.
From Meeting of the American Physical Society, Dallas, Tex.

43915 (UCLA-34-P-88-30) EIGHTH PROGRESS REPORT [ON SOLID-STATE AND MOLECULAR PHYSICS]. (California Univ., Los Angeles). 1 Apr 1970. Contract AT(11-1)-34. 33p. Dep. CFSTI.

43916 (UCRL-14722) PRINCIPLES OF HIGH-VOLTAGE PULSE REFLECTION-TYPE ATTENUATORS. Thomas, Robert J. (California Univ., Livermore. Lawrence Radiation Lab.). 11 May 1966. 33p. Dep. CFSTI.

43917 (UCRL-19137) EFFECT OF TRACE ELEMENTS ON PRECIPITATION IN Al-Cu ALLOYS. Das, S. K.; Thomas, G.; Rowcliffe, D. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr 1970. Contract W-7405-eng-48. 8p. (CONF-700809-1). Dep. CFSTI.
From 7th International Congress on Electron Microscopy, Grenoble, France.

43918 (UCRL-19187) VAPORIZATION KINETICS OF ZINC OXIDE AND CADMIUM SULFIDE SINGLE CRYSTALS. Leonard, Ralph Beaumont (California Univ., Berkeley. Lawrence Radiation Lab.). May 1970. Contract W-7405-eng-48. 130p. Dep. CFSTI.
Thesis.

43919 (UCRL-19198) HIGH VOLTAGE MICROSCOPY OBSERVATIONS OF DISLOCATIONS IN COBALT FERRITES. De Jonghe, L. C.; Bell, W. L. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar 1970. Contract W-7405-eng-48. 6p. Dep. CFSTI.

43920 (UCRL-19626) MECHANICAL PROPERTIES OF SOME METASTABLE AUSTENITIC ALLOYS. Bhandarkar, Dilip (California Univ., Berkeley. Lawrence Radiation Lab.). May 1970. Contract W-7405-eng-48. 75p. Dep. CFSTI.
Thesis.

43921 (UCRL-19631) DYNAMICAL THEORY OF KIKUCHI ELECTRONS. Tan, T. Y. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1970. Contract W-7405-eng-26. 4p. (CONF-701003-3). Dep. CFSTI.
From 28th Meeting on Electron Microscopy Society of America, Houston, Tex.

43922 (UCRL-19862) USE OF DATA-BASE ACCESS FOR INTERINDEXER COMMUNICATION AND FOR INDEXER TRAINING. Herr, J. Joanne (California Univ., Berkeley. Lawrence Radiation Lab.). Jul 1970. Contract W-7405-eng-48. 4p. (CONF-701004-2). Dep. CFSTI.
From 33rd Meeting of the American Society for Information Science, Philadelphia, Pa.

43923 (UCRL-19874) MAJOR TRENDS AND PORTENTS RELATED TO INFORMATION COSTS. Wilson, John H. Jr. (California Univ., Berkeley. Lawrence Radiation Lab.). Jul 1970. Contract W-7405-eng-48. 4p. (CONF-701004-1). Dep. CFSTI.
From 33rd Meeting of the American Society for Information Science, Philadelphia, Pa.

43924 (UCRL-19906) X-RAY STRUCTURE INVESTIGATION OF SOME SUBSTITUTED INDOLES, AND THE X-RAY CRYSTAL OF 1, 1'-BISHOMOCUBANE. Quarles, William G. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1970. Contract W-7405-eng-48. 173p. Dep. CFSTI.
Thesis.

43925 (UCRL-20037) THE PHOTOCHEMISTRY AND BIOCHEMISTRY OF AROMATIC N-OXIDES. Alkaitis, Algimantas Augustinas (California Univ., Berkeley. Lawrence Radiation Lab.). Sep 1970. Contract W-7405-eng-48. 122p. Dep. CFSTI.
Thesis.

43926 (UCRL-50849) AN AUTOMATED, HIGH-SENSITIVITY, THREE-COLUMN GAS CHROMATOGRAPH. Frazer, Jack W.;

Du Val, Virgil; Anderson, Roger E. (California Univ., Livermore. Lawrence Radiation Lab.). 21 Apr 1970. 15p. Dep. CFSTI.

43927 (UCRL-50852) STATIC DETERMINATION OF THE DEFORMATIONAL PROPERTIES OF SOLID MATERIALS WITH PRESSURE. Duba, A. G.; Schock, R. N. (California Univ., Livermore. Lawrence Radiation Lab.). 16 Apr 1970. 18p. Dep. CFSTI.

43928 (UCRL-50879) METHOD FOR EVALUATION AND CERTIFICATION OF THE SIP TRIOPTIC UNIVERSAL MEASURING MACHINE. Lane, Donald L. (California Univ., Livermore. Lawrence Radiation Lab.). 21 Apr 1970. 40p. Dep. CFSTI.

Results of 30 evaluation and certification tests developed at the Lawrence Radiation Laboratory for the SIP Trioptic Universal Measuring Machine are discussed. Photographs of each test setup are included. (auth)

43929 (UCRL-72574) MEASURED TIME AND FREQUENCY RESPONSE OF A MINIATURE SUPERCONDUCTING COAXIAL LINE. Nahman, N. S.; Ekstrom, M. P.; McCaa, W. D. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). 15 Jun 1970. 30p. (CONF-700618-1). Dep. CFSTI.

From Applied Superconductivity Conference, Boulder, Colo.

43930 (UR-49-1332) MEGAKARYOCYTOPOIETIC RESPONSE TO PLATELET DEPLETION. Nakeff, Alexander (Rochester Univ., N. Y. School of Medicine and Dentistry). 1970. 146p. Dep. CFSTI.

Thesis.

43931 (USC-113-P-10-X-1) PHOTOSENSITIZED AQUATION REACTIONS OF $Cr(NH_3)_5(NCS)^{2+}$. Martin, John E.; Adamson, Arthur W. (California Univ., Los Angeles. Dept. of Chemistry). [1969]. 30p. Dep. CFSTI.

43932 (WAPD-T-2311) APPLICATION OF CLASSICAL INDUSTRIAL ENGINEERING TECHNIQUES TO SYSTEMS ENGINEERING. Wuchina, Stephen W. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jul 1970. Contract AT-11-1-GEN-14. 46p. Dep. CFSTI.

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF
PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402
OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

TECHNICAL PROGRESS REVIEWS

The Division of Technical Information, U. S. Atomic Energy Commission, also publishes three journals on nuclear technology, the Technical Progress Reviews. These journals summarize, evaluate, and reference the progress of development in three important fields. *Nuclear Safety* is a bimonthly journal; the other two are quarterly journals.

Isotopes and Radiation Technology P. S. Baker, A. F. Rupp, and associates, Oak Ridge National Laboratory. Reviews AEC-sponsored projects and related significant worldwide developments in radioisotopes and radiation technology.

Nuclear Safety Wm. B. Cottrell, J. P. Blakely, W. H. Jordan, and associates, Nuclear Safety Information Center, Oak Ridge National Laboratory. Covers topics relevant to the analysis and control of hazards associated with nuclear reactors and with operations involving fissionable materials and the products of nuclear fission.

Reactor Technology Reviews reactor research, development, design practices, operating experience, and aerospace applications, as well as current developments in reactor fuel processing.

Availability

SUBSCRIPTION RATE: The Technical Progress Reviews may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402: *Nuclear Safety* at $3.50 per year (six issues) or $0.60 per issue; *Reactor Technology* at $3.00 per year (four issues) or $0.75 per issue; *Isotopes and Radiation Technology* at $2.50 per year (four issues) or $0.70 per issue.

POSTAGE: Postpaid within the United States, Canada, Mexico, and all Central and South American countries except Argentina, Brazil, Guyana, French Guiana, Surinam, and British Honduras. For these Central and South American countries and all other countries: add, for each annual subscription, $1.00 for *Nuclear Safety* and $0.75 for each of the other journals; for single issues, add one-fourth of the single-issue price.

REMITTANCE: Payment should be by check, money order, or document coupons and MUST accompany order. Remittances from foreign countries should be made by international money order or draft on an American bank payable to the Superintendent of Documents or by UNESCO book coupons.